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GUIDE TO NATURE-STUDY

FOR THE USE OF TEACHERS

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PREFACE.

The author has undertaken this work in the hope that it may be helpful to those teachers who are struggling in what, to them, is a comparatively new field of study. It is hoped that those, who have not yet taken advantage of the opportunities which Nature-study affords, may be induced to consider the benefits of this subject to the pupil and to the general work of the school.

The general purpose of the book is to set forth the true aim of Nature-study and thus to lay the foundation for correct methods in conducting it. In this it will be noted that emphasis is placed on the education of the child through his self-activity and by and through the realities of nature.

Part I deals with the Pedagogics of Nature-study. It endeavors to show that the best education can be obtained not by studying man alone—his history, language and literature—nor by studying natural science alone, but by taking a stand, as it were, midway between them, and uniting the two. In other words, it is to be obtained by studying man in relation to his environment—physical, intellectual and spiritual. Nature-study deals particularly with the child's physical environment, and, if properly conducted, relates this environment to his intellectual and spiritual needs, and thus gives him a higher conception of life.

Part II endeavors to show through "type-lessons" the mode of dealing with different departments of nature and the method of correlating Nature-study with the expressive work of the school—drawing, modelling, composition, literature and reading. Individual rather than collective work is prominent; at every step, the "how" and "why" of the child are emphasized. It will be readily seen that "cram" is impossible in true Nature-lessons, since many of the type-questions will require months of observation before they can be answered.

Part III must not be regarded as Nature-study. It is intended to give teachers who have not had a scientific training, and are,

therefore, not familiar with the work, an insight into the diff fields of study. The most important parts of these different fi considered from the child's point of view, are outlined. It is intended that this part should take the place of text-books the different sciences or that this information is to be me imparted to the pupils under the guise of Nature-study.

A list of the most helpful books at present on the marke given in Chapter VIII. The teacher should have as many possible of these at his command to guide and confirm him in observations.

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GUIDE TO NATURE-STUDY.

PART I.

CHAPTER I.

NATURE-STUDY.

The beauty which old Greece or Rome
Sung, painted, wrought, lies close at home;
  We need but eye and ear
In all our daily walks to trace
The outlines of incarnate grace,
  The hymns of gods to hear!

—*Whittier.*

The object of all education, of all training, is to teach s HOW TO LIVE.

Unless we have knowledge of the things concerning ur life, we cannot live life in its broadest and deepest ense. The kind of training that shows us the things bout us—the things of Nature—must certainly be the est kind of training, for upon these things are we ependent, not only for life, but also for happiness. Not o know something of the laws and love that bind all reation together in harmony and order, is, perhaps, to ose life's greatest pleasures and to be haunted by supertitions and fears.

Through direct contact with the things of Nature, the hild, if introduced to them properly, unconsciously ecomes a student and is likely to continue as such, for is individuality has a basis on which to work and ecomes his power. He feels himself being evolved out f himself. Only in the natural world has the imaginaion of the child free scope. To put anything in the

way of the full and free development of the chil imagination is to lead, unknowingly it may be, materialism.

In childhood the imagination is most active. Wh Because of the spirituality of the child. "Except become as a little child, ye shall in no wise enter into t kingdom of heaven." Unless crushed, this spirituali does not pass away as the child develops. On the oth hand, the things which are unseen and eternal becor realities to him. He has learned the meaning of l through his trained imagination, and can implicitly tru the guidance of the invisible but loving Father—G It is through the study of Nature that we can find t symbols that unlock and interpret the Holy Scriptur in which this loving Father is revealed to us.

> Go forth, under the open sky, and list
> To Nature's teachings, while from all around—
> Earth and her waters, and the depths of air—
> Comes a still voice.
>
> —*Bryant.*

The greatest writers of these and other days ha been keenest students of Nature. It was from Natu that Hawthorne, Browning, Tennyson, Wordswort Eliot and Chaucer drew their immortal songs a stories. Nature-study alone can reveal to the class student the Odes and Idyls of Horace and Theocritus, their full meaning and beauty. The modern-langua student, too, may well take his Schiller, his Goethe, h Hugo, his Dante, and his Heine, and seek their interpr tation through the quiet study of Nature, for there a there alone can he learn the true spirit of the writ Nature with her mysterious forces everywhere at wor gave to the Greeks, the Romans and the Norsemen t material for the wonderful myths that have told markedly on the history and culture of these peop The principles upon which great inventions have be made were first in Nature's keeping. She still possess secrets untold. There is not a nation or a people

om she has not revealed some of her secrets, and, as se always speak truth, there is not a people or a nation which we do not find some glimmerings of truth. eed, the power which a nation possesses to discover manipulate the forces of Nature makes her place ong the nations. The secrets of Nature are soonest ealed to those who love and search her. Whether Canadian children will love Nature, and how much ver they will acquire to discover and manipulate her rets, will depend to a great extent on their teachers.

CHAPTER II.

NATURE-STUDY OF THE PAST.

> Nature is but the name for an effect
> Whose cause is God
> The Lord of all, Himself through all diffused
> Sustains, and is the life of all that lives.
>
> —*Cowper.*

For many centuries the value and necessity of Nature-dy have been recognized by the leaders of education. ough thus recognized, little has been accomplished. any and varied have been the methods by which the cher has struggled to educate the child in Nature's oad fields. Method after method has, from time to ne, been cast aside as unsatisfactory. The probable use of the confusion and unsatisfactory results attend-g the teaching of this subject was no doubt the fact that e aim was not really definite, or the real object of the aining—TO OPEN UP LIFE—was lost sight of, and aims ich are now regarded as of primary importance were ven a secondary place, if thought of at all. Never was ild nature understood as it is to-day. Never before d the educator recognize as he does to-day the extent which the child lives his life in the world of Nature. it he now knows that the child finds, not only his

possibilities, but also his limitations. "Lead the c out into the world of Nature—it is his native air," cr Froebel. His cry is heard to-day in almost every co of our land. Many, however, who hear this cry, a wish to obey it, are without the light of the prese and hence are unable to lead the child aright. In or if possible, then, to show these where they stand and open up the new way, it may be well to review a few the old-time methods, showing their weakness.

I. Possibly the first school-introduction to Nat most of the present generation had, was through t teaching of isolated natural objects, such as wool, cott sugar, salt, coal, etc. Ease of description seemed to the only guide the teacher had in their selection. In t old text-books of our libraries we find long lists of su isolated objects. To evolve the qualities, properties a uses of these things was the chief aim of the teach The dead thing alone was studied. There was no id of the thing as a living whole, or as a part of a livi whole, in its presentation.

To-day we do not altogether discard such objects, b with the additional light of psychology and experien we recognize fully that the child, akin, as he is, to t living things of Nature, is more attracted by them a hence much more interested in them than by these de things. The living thing, as a whole, has most meani to him ... ice an object-lesson as taught during that peri woul... day, be only a small part of a Nature lesson pr per. It would be the outcome of a Nature-lesson. F instance, a lesson on leather would not be given as a isolated lesson at all, nor would it be touched upon un the child had, as it were, actually lived with the cow with the sheep. The life history of these animals, or a least one of them, would be fully studied by the chil to-day. He would then have to learn something abo the skin. Hand in hand, also, with such a lesson woul go the life history of a tree. The study of the bark the tree would then form a part of this life history. Th

f the bark and the tanning of the skin would thus e outcome of such a lesson.

Another phase of Nature-teaching through object-ns was to emphasize unduly the things of Nature contribute in a special way to the personal use of —as wheat, milk, beef, eggs, etc. Much information ng to these things was gathered, but there was no ght of presenting them as a dependent part of a whole as useful and as necessary to Nature's other en as to man. For instance, wheat was studied y as grain. The process by which wheat was made flour and bran, and then into bread, was carefully t. But the grain as the result of the work of the and its dependence during its work upon its onment were not noticed at all. Nor was any com-on of wheat made with other members of the same y. Whether the lesson was on an isolated object one useful to man, considerable attention was given e language of the child in order that he might be to give a written description of the objects under . The child was merely a receptive agent and made or no use of his own powers of observation.

teach the utility of things has its place, but more essary. There are depths below the surface. To-he teacher is seeking not only to emphasize the s most useful to man, but also to show use in every-. The beautiful has its uses. "Each thing in ace is best." To-day he will show that each living is an organism governed by fixed laws and espe-adapted to its environment; yet while apparently xistent, each is dependent upon every other. ing in Nature really stands alone, but each is gthened by the work of the other. Nor is the ng of the child's language neglected. It is not y accurate description stated in definite form. It is nguage of a full soul seeking words to express This attitude of the mind is necessary to good in composition.

III. Mere description of things, even of things ful to man, became burdensome. Useful things i ested the child only in a kind of way; hence ra striking things—the wonderful things of Natu were substituted for the useful in the hope that would interest the child more. Uncommon objects as the star fish, the sea urchin, the cotton pod and fo fruits were examined and described. Such storie "Giants of the North," and "Wonders of the Trop as well as those descriptive of birds, flowers, and markedly different from those the child was in habit of seeing, were told and read to children. gain to the child through the description of uncom objects was less than through objects especially us The *dead thing* was still before the child and the li him did not respond to the dead things before The value of the stories, notwithstanding the won ful things they described, was oftentimes lost on child, the descriptions not being vivid enough to b real pictures before his mind. Instead of te children of wonders such as the giant trees of tropics, or of glaciers, or of star fish, the aim to is to open their eyes to the wonders everyw around them—to the maple, the beech, or the rather than to a tropical tree; to the snow and ice: also to show that the more closely we exa the things in Nature the more wonderful they Everything in Nature is wonderful. We do not be these wonders because we do not look at Nature seeing eyes. The seeing eye and the hearing ear ca be produced by any mere description, but by a lo close companionship with the things of life and bea by seeking to know Nature in her real form—as sh in the forest, in the field and in the garden. Burns been spoken of as

> "One of the few, the immortal names,
> That were not born to die."

The opening of the eyes of the people of Scotland to

wonders of Nature everywhere around them—to the beauty at their own doors—was, says George Macdonald, the secret of Burns's great power. This poet put his life into his song. And he lived his life through the common things about him.

IV. In time the study of isolated object-lessons on dead things was supplanted by the study of living animals, birds, fish and trees. Little discrimination, however, was exercised concerning the animals and trees selected for study. The tendency was, indeed, to present those foreign to the child. Pictures of living things were frequently substituted for the living things themselves. This did not satisfy the child. Then, too, the field was so extensive that to avoid confusing the child, scientific classification was introduced. Hence, more form and system were emphasized at every step, and nature-lessons became purely elementary science-lessons. Not only did these lessons attempt to show unity in the different sciences. In fact, so dry did they become that they neither interested nor instructed the child. In many cases they imperceptibly became, in the hands of the very teachers aiming at progress, the old-time object-lessons.

V. In the light of the present, teachers recognize the fact that to become acquainted with the many, the few must be mastered, hence types with which the child can become familiar are now selected for special study. Things foreign are presented to the child through comparison with things at home. Then, too, Nature-study of to-day, aiming as it does to PRESERVE LIFE, and to follow the LAWS that underlie it, must be truly scientific in that it leads each to become a searcher of truth. To-day we do not gather facts from one field of science and classify these, but we collect facts from every field in such a way that in time the mind correlates them and places them in the different fields to which they belong. In this way the foundation of classification will be laid. For example: In studying the life history of an animal,

its home and its food must be considered ; hence
invade the sciences of botany, geography and proba
geology, entomology, meteorology, physiology,
Then, too, without the knowledge of certain nat
phenomena during the different seasons, only part o
life can be studied. These sciences, however, do
stand out alone before the child, but as related
dependent on each other, each reacting in its own
on the life under special observation. Hence, we
that scientific classification will, in time, come to the c
as a natural outcome of his work. The primary p
cannot generalize sufficiently to be able to make a cla
fication and hence this should not be forced upon
by the teacher. In the light of the present, classifica
is treated as an incidental—as an outcome of a sys
that uses scientific facts as mere speaking tubes thro
which so to fill the child with the spirit of Nature
love, its laws, its truth, its beauties, as to make him l
for daily companionship with it. In time the resul
training will react on the child's character. It will m
him as true to his life as the things of Nature are to th
This, and this alone, can be the true aim of Nat
teaching.

In every lesson the teacher should be conscious o
definite purpose. The well-intentioned purpose may
of accomplishment on account of inadequate or incor
method. This is particularly true of Nature-study, wh
central aim is the exercise of the pupil's powers in
discovery of truth—practice in philosophical observat
"The first essential," writes Prof. L. H. Bailey,
positive, direct, discriminating, accurate observation ;
second essential is to understand *why* the thing is so
what it means ; the third essential is the desire to k
more—this comes of itself ; and the final result is
development of a keen personal interest in every nat
object and phenomenon." Many a so-called Nat
study lesson, although it may have had some humani
ian value, or afforded opportunity for language prac

increased a second-hand knowledge of Nature, has ked these essential qualities.

he teacher essaying to teach a Nature-study lesson, failing in the attempt, usually fails for one of the owing reasons. He mistakes giving knowledge about ture for training the pupil to investigate and interpret environment. The most useful result of this instruc- n is the oral or written recapitulation by the pupil of h second-hand knowledge with which such lessons are ally concluded. Or, the lesson may be made one in mal science. "When the teacher," aptly says Prof. iley, "thinks mostly of his subject he teaches science; en he thinks chiefly of his pupil he teaches Nature- dy." Objects are freely used in science as well as in ture-study; but, in the latter, knowledge is almost, hough not necessarily, wholly restricted to what the ld can be led to discover. In no other study than in one under consideration should the maxim—do not l the child what he can find out for himself—be so rsistently observed. Not even a story, picture or em should be obtruded between the child and the ject that his interest is concentrated upon. Picture d verse have their appropriate turn after Nature her- f has spoken. One of the Cornell Nature-study flets is devoted to the Oak. It describes seven mmon species, adding expressive pictures of the fruit d foliage of each. The leaflet bears this direction in lics: "It is especially urged that this leaflet shall not placed in the pupils' hands; it is prepared to enable e teacher to ask suggestive questions." This direction rows strong light on the right method of the Nature- dy lesson. A teacher of botany, while advising or quiring his pupils to collect or examine acorns, leaves, rk, etc., would probably not hesitate to put this illus- ated leaflet in their hands. In the main he uses the jective method, but he aims at a quantum of system- ized, scientific knowledge. The Nature-study teacher, the contrary, cares less for the knowledge, but he is

deeply concerned with the effect that the process acquiring the knowledge, be it much or little, has up the mental powers and character of the pupils; he alert to the signs of intellectual growth, insight, inter and sympathy.

The following lessons on the Wasp are used to ill trate differences in aim and method :—

Information lesson

I.

TEACHER.—The other day we had a lesson ab The Bee. This afternoon our subject is The Wa Who can tell me what a wasp is?

PUPIL.—It is a black insect.

SECOND PUPIL.—It can sting like a bee, but worse

T.—How large is it?

P.—It is about an inch long, but not so thick as a b

T.—What is peculiar about its body?

P.—Its body is small in the middle.

T.—Yes; its body is said to be constricted betw the thorax and the abdomen. (Illustrated by teacher on the blackboard.) The picture of the w explains the meaning of the word "wasp-waiste Wasps are irritable and revengeful, hence the w "waspish" is sometimes applied to disagreeable peo (The class practised, using the words "constrict "thorax," "waspish," and "irritable.")

T.—In what other way than having a sting does wasp resemble the bee?

(No answer.)

T.—Does it live alone?

P.—No; it lives in a hive with other wasps.

T.—Yes; bees and wasps are said to be social inse They live in communities. Each community of wa is started in the spring by a single female. Who seen a wasp's nest?

(Three or four pupils raised hands, to one of whom a permission was given to draw a nest on the blackboard. A fairly good drawing of a hornet's nest recalled the subject to several other pupils, who correctly answered questions about the size, colour, material and chambered interior of the nest.)

T.—This nest I have in my hand is made by a different kind of wasp from the one that makes the nest figured on the blackboard. I'll pass it round, that you may see the number and shape of the cells, and the material of which it is made. (The nest was that of a common species of Polistes.)

T.—How are wasps' nests different from bees'?

P.—There is no honey in them.

T.—That is right; but how else do they differ?

P.—A bee's hive is made of wax, but a wasp's is made of stuff like paper.

T.—Where do bees get wax?

P.—Out of flowers.

T.—Where do wasps get their paper?

(No answer.)

T.—They scrape the weathered surface off old boards, and work it in their mouths into a pulp. This, when spread on the edge of their nest and dried, becomes our paper. Wasps were the first paper-makers.

T.—What do wasps eat?

(No answer.)

T.—They get honey out of flowers like bees, and they are fond of sucking the juices of ripe fruits. They also act as scavengers, and eat flies and meat and greasy substances of various kinds. I have read that they have been known to strip the flesh off the bones of a dead horse.

T.—Now take your books and write an account of the wasp under the following headings:—

Comparison of the Wasp and the Bee.

Home of the Wasp; make a drawing of the ne showed you.

Food of Wasps.

The foregoing, which was misnamed a Nature-st lesson on Wasps, is reported from memory. If, whic doubtful, it interested any pupil in these insects, and him to investigate their habits, it served to that ext one of the purposes of a Nature-study lesson. modicum of investigation was insured by the directio draw the nest that was passed round. A few memb of the class had seen wasps and wasps' nests, and th did all the original answering. It is not far wrong to that it remained to the practice in English composit to redeem the lesson from being a waste of time.

Elementary Science L. II.

Each pupil is supplied with a chloroformed w The teacher by judicious questioning leads the pupil examine the specimens, and to record that:

(*a*) The insect is four-winged;

(*b*) The wings are membranous and all of sim texture, unclothed;

(*c*) The front pair is folded, and larger than the h pair;

(*d*) The wings lack cross-veins, and have only closed submarginal cell;

(*e*) The mandibles are distinct, palpi small;

(*f*) The tarsi are five-jointed;

(*g*) The prothorax is horny.

They turn from the insect to the analytical key in text-book, and determine that their insect is one of *Hymenoptera*. Further investigation reveals that:

(*a*) The trochanters of the hind-legs consist each single piece;

(b) The insect is provided with a sting;
(c) The front wings are folded once, longitudinally;
(d) The veins, V_2 and V_3, arise from the second submarginal cell.

These are the characters which distinguish *Vespina.* A black or brown abdomen, ringed with yellow, shows that the genus is *Polistes.*

Having so far identified the insect, the interesting information contained in the entomological text-books is now available. The class now learns that the female Polistes, surviving the winter in some sheltered cranny, comes out in the warm spring days to establish a colony, housed in an unenveloped nest, with fewer cells than are contained in those elaborate affairs built by her cousins, the hornet and yellow-jacket.

No. II. is a lesson in formal science. The teacher uses insect, text-book, technical term, exact definition, diagram, and whatever else will give the class definite concepts of structure and relation—a quantity of scientific knowledge—without much regard to the interests or needs of individual pupils.

III.

However admirably the wasp may be adapted for study by a single observer or a small group, conditions will seldom occur making it a suitable subject for Nature-study by a large class. Wasps are easily collected and preserved for comparison with other insects, and hence may be used for comparing structure in one or more of a series of Nature-study lessons on the grasshopper, June-beetle, house-fly or other insect. Or in a series of Nature-study lessons on insect homes, the nests of hornets, yellow-jackets, Polistes, mud-daubers, miners and other kinds of wasps would surely be observed.

Under the direction of a skilful teacher, with sufficient knowledge of practical entomology, genuine Nature-study work can be done with the wasp. The insect's dangerous

temper, instead of being an objection, may give ze[st to] the observations.

Let us suppose that a wasp is observed starting a [nest] in a situation convenient for study by the class.

Attention will be directed to the nest and e[very] observer encouraged to search for similar struct[ures] elsewhere.

How is the nest suspended?

If it be a hornet's nest, how many central cells [are] constructed before the external envelope is commenc[ed]?

How does the wasp manufacture the nest mate[rial], and how does it build it into the nest?

What is the shape and size of the individual cells?

What is deposited in each cell?

In how many days does the egg hatch?

How are the larvæ fed?

How many days does the larval condition contin[ue]?

Describe the pupa.

When the pupæ emerge, how do they divide [the] labour of home making with the founder of the colo[ny]?

Describe the different kinds of cells and watch [the] different forms of wasps that emerge from them. Le[arn] to distinguish queens, drones, and workers if any.

Cage a few wasps in a box having the top clo[sely] covered with wire netting. Feed them through a [trap] door in the side of the box. Try moist sugar, little [bits] of meat, house-flies, and other kinds of food, to le[arn] what they will eat and what are their preferen[ces]. Observe the action of their antennæ and how they se[ek] their food. Discover whether they are of any use to m[an].

On a cool evening in early fall capture a nest and c[age] it as above, placing the separated combs in inve[rted] position in the box. Supply the wasps with food -sw[eet] solutions for the adults, and bits of raw meat for [the] young ones—and observe how the different kinds

ure wasps feed the larvæ and prosecute their other es as housekeepers.

very pupil is required to make a truthful, dated record is observations. He knows that not only the statets, but also the English and penmanship of his ences, will receive the teacher's notice. His drawings t aim at beauty as well as accuracy. Probably his rts will be submitted to the teacher on practice paper re being entered in his Nature-study book.

---

omparison of these lessons will reveal some of the ons why real Nature-study teaching has not been e rapidly introduced. For Nos. I. and II. a definite n can be devised; the time can be fixed a week or nonth ahead; they fit into the programme of an inary school as neatly as history or arithmetic. III. is not a definite half-hour's lesson; it is a series rregular lessons extending over an indefinite period, or three minutes to-day, a quarter of an hour next k, and so on. And yet the teacher whose methods school organization admit of no elasticity, can surunt this difficulty by giving the Nature-study work nite limitations on his time-table, and carrying along e or four lines of investigation simultaneously. One ng, if not another, can be depended on to occupy the e.

Another, and probably a more serious difficulty in way of real Nature-study, is the amount of preatory work required of the teacher. Sitting in one's ir and reading a book seems an easy way of preparing esson. Little else is required for Lessons I. and II., for study by observation and investigation, as in III., one needs to be out of doors with the children, make boxes, to procure food daily, and to do various nticipated duties. Then there is the resisting of the

temptation to tell the pupils interesting bits of kn ledge that they should be left to discover, and restrai the impatience of the quick pupils to announce t discoveries prematurely, in the hearing of their fell

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CHAPTER III.

PLEA FOR NATURE-TEACHING.

> Earth is crammed with Heaven,
> And every common bush afire with God,
> But only he who sees takes off his shoes.
>
> —*Elizabeth Barrett Browni*

By reviewing the past and looking into the fut the leaders in the child world to-day feel that only safe position for the teacher is by the side *of child.* A little child must be set in our midst. must become as a little child. We must be led t great extent by a little child. The whole realm Nature is the child's birthright. It is his native air. materials in Nature belong to the child as truly they do to the greatest scientist, and, indeed, what m beautiful picture or more lovely intercourse than tha a little child and a great scientist walking hand in h in the world of Nature, learning, as each may learn, lessons of truth and worship. All's love, yet all's can be made plain alike to each.

To those who are surprised at the recommendatio such a course, and regard it as chimerical, we wo reply: The greatest scientists cannot fully underst "the flower of the crannied wall," and yet from same flower the child can learn much of love beauty. The meanest flower that blows can thoughts to the child, as well as to the scientist, must ever say—

> Behold, we know not anything;
> I can but trust that good shall fall
> At last—far off—at last, to all,
> And every winter change to spring.
>
> So runs my dream; but what am I?
> An infant crying in the night;
> An infant crying for the light;
> And with no language but a cry.
>
> —*Tennyson.*

[illegible]t the child is perfectly at home in Nature's great [illegible]hop, is constantly shown by the pleasure he takes [illegible] rambles and investigations as he seems to seek for [illegible]r insight into all kinds of attractions that charm [illegible] the way, and call out his best energies, physical [illegible]ental. Not to lead the child out into the world of [illegible]e is to deprive him of his birthright. He may take [illegible]ssion of his own from the time he begins to take [illegible]. Birds, flowers, trees, bugs, dogs, cats, [illegible]ow, ice, [illegible] are his earliest companions, and a teacher has no [illegible] to deprive him of this birthright after entering [illegible]. In any case these are the only things that at [illegible]nterest him. They are the only things he can [illegible]stand—the life in him responds to the life in them. [illegible]erest is the key to all progress—"Attention is the [illegible]memory is made of." From the very beginning [illegible]hool-life the teacher should make use of those [illegible]ials which are an expression to the child of his [illegible]nd which attract his observation and appeal to his [illegible]nation. From time to time he is to use them to [illegible] the child to express his thoughts by such means as [illegible]lling, and drawing until the more abstract expres[illegible]hrough words has a real meaning for him; and, [illegible]d, it may be said, until his pen becomes as responsive [illegible] tongue.

[illegible]thing else seems to make the child so gentle, so [illegible]athetic, so compassionate, as this direct contact [illegible] Nature. Then, too, where are we to go but to [illegible]e to learn reverence and law-abiding qualities, as

well as to see the beautiful and harmonious in all different forms? A child filled with the spirit of Na and with a love for the study of Nature, becomes a better scientist than he could have become without study. He has learned to love things as they direct from the hands of the Creator, and each is to an expression of that Creator's love for His creat

How others regard a study of the common th about them, the following will show:—Carlyle "For many years it has been one of my most con regrets that no schoolmaster of mine had a knowl of natural history, so far at least as to have taugh the grasses that grow by the wayside, and the winged and wingless neighbours that are contin meeting me with salutations which I cannot answe things are. Why did not somebody teach me the stellations, too, and make me at home in the st heavens which are always overhead, and which I d half know to this day?"

John Burroughs says ("Birds and Poets"): "If k ledge alone made literature, or culture genius, would be no dearth of these things among the mod But I feel bound to say that there is something de than the influence or perusal of any or of all book all other productions of genius—a quality of inform which the masters can never impart, and which libraries do not hold. This is the absorption b author, previous to becoming so, of the spirit of N through the visible objects of the universe, and affiliation with them subjectively and objectively. more surely is the blood quickened and purified contact with the unbreathed air, than is the spirit of vitalized and made strong by intercourse with real th of earth. The calm, all-permitting, worldless spir Nature—yet so eloquent to him who hath ears to h The sunrise, the heaving sea, the woods and moun the storm and the whistling wind, the gentle sum day, the winter sights and sounds, the night and

e of stars,—to have really pursued these, especially
childhood onward, till what there is in them possible
fine finds its full mate and echo in the mind—this
is the lore which breathes the breath of life into all
est."

v. Edward Herrick Chandler says: "To lead a
child into this beautiful world and open his eyes to
narvels which await him, is a most precious privilege.
could stumble along without leadership, and he
d see many things. But how much a guide is
h! Parents may well put themselves to great pains
he sake of introducing their children to Nature.
effort will bring any greater reward. They may
these young eyes to the colour of the birds, to
arieties of the trees, to the delicate beauty of the
nonest wayside flower, to the intricate traceries of a
rfly's wing, or the grace of a clinging vine, to the
of the sunset and the grandeur of the lightning.
dren may be taught to distinguish bird notes and
e the common birds. Their eyes may be trained to
armonies of colour and the marvellous detail in the
and the snowflake. No child will be cruel to birds
sects or animals of any sort, if he is properly intro-
d to them and learns their true place in God's mar-
us universe. A sensitiveness to the beauty of the
d and the infinite love manifested in its wonderful
rces, means much to develop the mature character.
is wanting in many a man and woman because
e was no one to guide their early years."

erbert Spencer says: "Whoever has not in youth
cted plants and insects, knows not half the halo of
est which lanes and hedgerows can assume. Who-
has not sought for fossils has little idea of the poetic
ciations that surround the place where imbedded
ures are found. Whoever at the seaside has not
a microscope and aquarium, has yet to learn what
ighest pleasures of the seaside are."

H. H. Ballard, President of the National Ag Association, Pittsfield, Mass., says:

"The most natural study is the study of Nature."

"Sensible training trains the senses."

"Scientific training is the antidote for superstition

"Knowledge equals true perceptions plus righ ferences."

"The study of Nature is a physical tonic, a m stimulant, and a moral antiseptic."

"Nature study induces simple manners and morals."

Perhaps one of the strongest pleas for the stud Nature, and certainly one worthy our consideratio that advanced by Dr. Justus Gaul, of the Universit Zurich, in one of his recent lectures on "Alcohol Happiness." It is in brief as follows:—The fact th many men not only passionately seek the pleasures w alcohol brings, but also value and prefer them to pleasures, must have deep psychological ground. does alcohol increase the feeling of happiness? The uses its powers in resisting the outside forces which upon it. Normally there is a balance between body environment. If environment prevails our spirits and our happiness grows. Alcohol dulls our apprecia of powers outside of us, until they seem so much sm that we are sure we can conquer them, and so we a feeling of satisfaction and superiority. Can conquer the forces that press in upon him and make t subservient? Ah, yes, if he will but use his intellig to understand them, instead of stupefying himself. not the new appreciation of Nature in this cen revealed a source of joy which our forefathers did know? The world is full of pleasures that charm i will but lift the veil which hides its secrets. Who could have known formerly that a glimpse of the or the raging sea, could give pleasure which really m strong and furnishes recompense for trouble and t

new insights into the secrets of Nature, the general emination of art so that even the masses may enjoy works—these are worth much more to alleviate care n anything known of old. But it comes so slowly, e say. It takes the masses so long to acquire the er to appreciate these things. This fact should make ll the more alert as to the ways and means of teach- the child how best to become acquainted with Nature, she may help to alleviate the cares and troubles will inevitably be his in the future.

Vith such testimonies before us, and with the experi- of the last two hundred years, both in Europe and merica, who can doubt the fact that real instruction ns with things as found in Nature rather than with a ription of them as found in books; or who would, in ace of these testimonies and experiences, deprive the d of this real instruction by presenting first to him a book—a mass of unintelligible words and phrases er than the living book of Nature where things alone be seen in their true setting? *"Open the living book— iving book of Nature—to the child," should be the cry the whole of our land.*

CHAPTER IV.

PLACE GIVEN TO NATURE-LESSONS

Nature never did betray
The heart that loved her; 'tis her privilege
Through all the years of this our life to lead
From joy to joy; for she can so inform
The mind that is within us, and so feed
With lofty thoughts,—that naught shall e'er disturb
Our cheerful faith, that all which we behold
Is full of blessing.

—*Wordsworth.*

ature-study should have a place on our school cur- um equal in importance to mathematics, reading or ture. Indeed, in the primary department, it should

have first place. The systematic study of Nature sh be begun in this department and should be conti through all the grades. Nor should there be any ya ing gaps either between babyhood and school lif between one grade and another. The work of form should be made to blend gradually and natu with that of the next. Then, too, Nature-study sh not only have a place on the programme as outline each grade, but it should receive due attention each in every class. When we say that Nature-study incl the same broad territory in the physical world as natural sciences (botany, zoology, physical geogra chemistry, physiology, meteorology), and that su study must have a place on our school curriculum, m may be dismayed and ask if a university course is t completed in the primary class. Such an attitude such a question would certainly be justifiable, were field of investigation not viewed from the standpoi the child, who regards it as including things with w he is now more or less familiar and which he lon understand more fully.

It must be remembered, too, that Nature-study only unifies the sciences, but it is also the root-c from which many of the other subjects spring, a Nature-study has its right place on the progra of the different grades, and its just allotment of other subjects will not require so much attention. example, Nature-lessons on the squirrel could n taught without teaching more or less geography, b and zoology. Such lessons must certainly lead child to visit the home of the squirrel, both winte summer, and to observe its habits during these sea This necessitates the teaching of geography. again, the surroundings of the home as to trees plants must surely be observed, hence a certain am of botany must be taught. Nor will the teachir zoology be limited to the squirrel himself. The an associated with the squirrel in any way will als

d by the child. The lesson should now take r turn. Heretofore the child has been gathering ation and receiving impressions. Unless he is to give expression to the thought within, through d signs, much, very much, of the value of the will have been lost. In no other way can this be done than through drawing. (See Nature-study lf-expression, Chapter VIII.) Too much looking ndling, without exercising the activities involved ression, tends to make the child stupid and s.

entres where Nature-study has been given its place, educators have been surprised at the ful developments and revolutions in the child's of thought. But the World of Nature is a big and the child has a big nature. Educators feel yet little land has been possessed. The question h teacher to ask himself is, how shall I move d to possess more of this land? This is an import- stion for the pedagogical world.

how, it may be asked, does the child look at 's broad field? He looks at it simply as interesting l that he meets everywhere—turn which way he s material he longs to understand, for through it ving his life. Instead, then, of giving a place to , chemistry, zoology, etc., on the programme of studies, give a place to the broad divisions of which would in all probability be made by d himself. These might be noted as follows: WEATHER (including natural phenomena). 2. LS (mammals, reptiles, birds, fish, insects). 3. S (trees, flowers, fruits, seeds, etc.). 4. THE EARTH oil, stones, forms of land and water). 5. PHEN- 6. SUN, MOON AND STARS. 7. THE PROCESSES FARM AND STREET. 8. THE CHILD HIMSELF.

CHAPTER V.

HOW TO PRESENT NATURE-LESSONS.

> The meanest flowerets of the vale,
> The simplest note that swells the gale,
> The common sun, the air, the skies,
> To him are opening paradise.
>
> —G

Taking his stand by the side of the little child, this axiom of the ancients as his guide, viz., th who knows one truth knows all truths, let the te aim at the following :—

A. 1. To permeate the whole being of the child the *spirit of Nature.*

2. To show Nature as she is. (*a*) The fish swims and breathes. (*b*) The bird as it sings and (*c*) The squirrel in its home. (*d*) The flower grows. (*e*) The bud as it forms on the plants. (*f*) snow as it falls, etc.

3. To keep life the central thought.

4. To discover the laws underlying life.

5. To see that the common things of the neigh hood first receive attention.

6. To allow the season of the year to be one o influences to determine what is to be studied.

7. To endeavour to have the child use the best of expression for elucidating the particular subject u study.

The love for outdoor exercise, for fresh air, is in in the child, and the teacher must meet the child o own ground. He should plan outdoor excursion his class, accompany the children and be a fellow-w with them, but he should not forget to be their also. He should have a definite aim in view for excursion and direct the energies toward that

s should also be directed before the lesson as to they should observe. A number of questions might ven to the class on Monday, the answers of which ot to be taken till Friday afternoon, thus giving days between for observation. The observations d be continued until the child is actually acquainted he point in hand. Knowing the class as individuals, eacher should anticipate questions and be prepared eet the child on his own ground. Information red should be made to tell on the school-room work ery possible way. Long excursions are not neces- indeed they are often inconvenient and impracti- . An excursion or a walk of a few blocks, even in owded city, can be made to furnish plenty of rial and ample scope for the Nature-teaching dur- term. If children cannot be brought out of the l room for even a few blocks (this may be the case e school is in the crowded part of the city), the er should endeavour to bring as much as he pos- can of Nature into the school room. A small tree, whole plant, root and all, can be brought in. Seeds e planted in window boxes. Pet animals may be ght to school. Insects can be kept in boxes. It is hoped that the time will soon come when a garden collection of animals will be considered as neces- equipments to a school as are our black-boards and . (See equipment, Chapter IX.) A basis for rea- g, however, must come from observing Nature as s, and should always precede school-room instruc-

To STUDY NATURE IN HER WHOLES.—Only by ying Nature in her wholes can the laws that govern e noted. Let the thought of "the whole" be con- ly kept in the mind of the teacher. To deal with re otherwise would be to return to the old-time t-lessons. Children are not as prone to look on the ce of things as is generally supposed. The "why and the "why that" of the child can only be satis-

fied by showing the laws that govern the parti thing under study. "The why" of the child sh always be treated with respect.

> In children a great curiousness is well,
> Who have themselves to learn and all the world.
>
> —*Tenny*

Only by understanding Nature in her wholes can parts be understood. (*a*) The study of buds should end with separate lessons on this particular part of plant, but the buds of a certain tree should be stu in connection with the whole life history of the (*b*) A feather should not be studied simply as a fea but as the feather of some particular bird. (*c*) home of the beaver should not be studied as a of skilful workmanship of a certain animal called beaver, but as only one thing in connection with whole life history.

By understanding the relation of the parts to whole and the laws underlying them, the world, a child looks out upon it, will be to him a related, li whole, the glory of the Great Creator. Nature will him the great workshop of the world. Each thin Nature will be one of the machines of this great works the parts of which he will see working together to per the special work planned for that particular machin the manager of the workshop. The more thoro a child can be made to understand Nature, the gr will be his realization of life. The more real love he for Nature, the more interest will he take in it. greater his interest, the more rapid will be his prog The more real progress he makes, the more truly his character be built and strengthened. *To build acter is the aim of all true education.*

C. TO COMPREHEND THE UNDERLYING LAW NATURE.—Since, then, the child becomes edu through Nature in proportion as he is permeated its spirit through understanding its laws, the te

d strive *to see below the surface* and cause the *child* uggle to see what is to be found there. Some of e's laws are apparent to even the smallest child. s are difficult to comprehend and can be under- only by the scholar; while others again, as the ist well knows, are still in her own keeping.

h laws as the following are within the comprehen- f young children. Indeed very few Nature-lessons taught without showing one or more of them.

daptation of Structure to Habit and Environment.—thing in its place is best, and each thing is adapted shape of its body, and by its different organs, to w and where it does. The form of the body under n conditions changes to fit its environment.

Division of Labour.—The great work of the world is d. Everything in the world has its own particular o do. Each part of everything has its work to do.

Order and Harmony.—To everything there is a season time to every purpose under the heavens. Every- order is observed, as in the movements of the ly bodies, in the alternation of day and night, in fferent seasons, in the work of plants, and of s, and in the beauty of construction and harmony ur in Nature.

Chain of Growth.—Man is immortal till his work is So is everything in Nature; when the purpose for it came is accomplished, it dies.

nterdependence of Things in Nature.—Nothing in this is absolutely independent; no one thing is self- t. Animals are dependent upon plants. Both pendent upon environment, etc.

ative impulse in the child is *rhythm*. Froebel erhaps, the first educator to recognize this in a al way. Froebel's games and songs for mother ild show how well he understood this impulse. ngs appeal to the child in a double way, first, by thm of the song itself, and second, by the realiza-

tion of the life in Nature which they seek to represent. Beauty of form, colour, proportion, all indeed that appeals to the æsthetic part of the child's nature is really a part of rhythm or number. Kindergarten rhymes should, in the public schools, give place to beautiful *gems of literature.* These should be selections from the best poems of the greatest poets of our own and other lands. Children do not look as much on the surface as is generally supposed. There is bread for the babe, bread for the workingman, and also bread for the thinker. The bread is the same in kind. It is, however, served in different quantities and in varied forms. It is not too much to ask a little child of seven to commit to memory "Flower in the Crannied Wall." Gems of literature should bear on the Nature-subject in hand. Thus after a lesson on the robin, teach one of the many beautiful little poems written on this bird. Songs also should supplement Nature-lessons, and should, like the gems, bear on the subject.

Nature-stories that appeal directly to the imagination of the child should have a place in every school. They appeal to him and reveal Nature to him as nothing else can, for they speak to him through his own life. The teacher should allow this faculty full, healthful play both in himself and in the little child. Fairy-stories, myths, and fables should be encouraged on all sides, but meaningless babyisms should be far beneath both teacher and child, nor should the point in hand ever be strained to impersonate this or that for the sake of presenting a living form to the child as is done at times in referring to the letters of the alphabet as animals, nor should it be strained for the sake of analogies that may exist, but which are far beyond the reach of the child's mind. The imagination should always have its dwelling in a certain truth, the knowledge of which would be helpful in the development of the child, and only the fable, the parable, or the metaphor that teaches that truth and impresses it upon the child, should be

ed. Nature-lessons deal particularly with facts, and ese facts should not be clothed by the imagination in ch a way as to be lost. Only the imagination that ings out the fact in striking relief is justifiable.

Stories and fables relating to Nature should be con- antly and rightly used, especially in reading and mposition lessons on Nature. It is well to remem- r that mere emotion must never be substituted for tient enquiry, and sentiment must be treated as an cidental in interpreting Nature.

CHAPTER VI.

SELECTION OF TOPICS.

> **Aloft on sky and mountain wall**
> **Are God's great pictures hung,**
> **Beauty seen is never lost,**
> **God's colors all are fast.**
> **The glory of this sunset heaven**
> **Into my soul has passed.**
>
> —*Whittier.*

In many cases the topics selected for the different ades are the same. The same things appeal to the ild whether he is in the fourth or the first grade. The atment, however, of the topics should be different. should be suited to the child's present capacity. Select- g topics and treating them thus has the following vantages:—1. The work of the first grade is reviewed d built upon in the second. The work of the second ade is reviewed and built upon in the third, etc. 2. e teacher can prepare not only his present work, but gets a view of the work before him and behind him. ence there need be no breaks in the work. 3. No anch of Nature-study nor any particular phase of it eives undue prominence. 4. It prevents him from duly emphasizing the side of Nature he likes best nself.

I.—In order to select topics properly, the differ fields for Nature-study should be kept before mind and selections made from each suited to grade. Each school must select its own topics. T selection will depend somewhat on the locality. T teacher alone can judge for his class the order which the topics from the different fields sho follow one another. Nature-lessons will have to taught upon particular subjects when material can obtained and when observations can be made. Si pupils are usually promoted in September, the top as outlined in this book begin in autumn. T topics are so arranged, however, that the teacher m if he deem it wise, begin in the spring with spring topics.

II.—In order to deal with the topics chosen, in way to be most beneficial, certain types have b selected for special study. Those selected should those that can be most conveniently watched by child and those that appeal most to him. In Natu study it is not *what* we study, but *how* we study it t is important. These types should become centres ro which work can be done. They should repres a large class of more or less similar objects, so t from the beginning the comparative method may used. Each type should be a connecting link betw that which the child has studied and that which he is study. The types should be milestones pointing out way. For example:—The cat has been selected as type of quadrupeds; the hen as the type of birds; maple as the type of trees, and the bee as the type insects. It is intended that each type taken from different classes selected should be studied in its history. But it must be remembered that to compl a life history may require several seasons of obser tion. It will require study in several grades. example:—If the study of the apple is begun in autumn in the first grade all its parts are examin

s uses are discovered; it is modelled, drawn and inted. In the spring the tree as it buds and opens o flower is watched and the flower examined, sketched d painted. Then the development of the apple itself watched during the holidays. Autumn is here again. any pupils in the first grade have been promoted to e second grade. The study of the apple is continued. has more meaning to them in every way. In the ring these pupils should plant apple seeds and watch e young plants developing; also study the apple e—how it is planted, how it grows. Observe the owth of the different limbs, etc. In the third grade ll more can be grasped about the apple and the tree: ., the relation of insects thereto, grafting, kinds of ples, picking them, their transportation in cold rage, etc. In the fourth grade all the information tained should be summed up, and the life history observed placed clearly before the child. Suppose, ain, the type being studied is "The Hen." We deal h it somewhat as follows:—1. Its general appear- ce (beauty of form and feather); 2. Analysis of rts; 3. Use of each part (division of labour); 4. laptation of structure to habit; 5. Comparison of ferent types; 6. Recognition of others of the same nily; 7. Uses—dead and alive. Beside the above, part of the life history that does not lie directly the surface should be carefully studied, viz., its in- ncts; its adaptations to surroundings; its internal gans; its food in winter and summer; its young—how reats them; its language; its eggs. It should be studied h winter and summer, and its observation should be ntinued through the grades. The order in which the ferent points should be dealt with depends entirely on circumstances under which observations are made. less such a comprehensive course of study is thus ered upon the unity of life as manifested in the follow- relationships cannot be shown, viz.: that between the mal and the vegetable kingdoms; the part played

by animals in the fertilization of the soil; the effect of rain on the soil; man's use of the things in Nature, and the dependence of all things in Nature on the love of the Creator. To see Nature in this light is the best foundation for morals and religion.

III.—The types selected from the different fields of Nature present many different phases. From time to time special opportunities will occur whereby these phases can be emphasized. Hence these should be kept constantly before the mind of the teacher, in order to seize a favorable opportunity for presenting them; yet no attempt should be made at straining any lesson in hand, nor should it ever be forgotten *that the important thing is the method in which all lessons on every topic are presented.* The kind of training that the lesson best gives is the phase to be emphasized. This is most important for success in Nature-teaching. 1. Some lessons appeal in a special way to **the senses of the child.** These train the child to observe closely and accurately, and to report with judgment. Such are lessons on animals, their habits, their bodies, the growth of certain twigs, etc. 2. Other lessons are again especially designed to train **thought and reason.** Such are the following, viz.: The way the little chick gets out of the egg; how the feathers are formed; why fish do not need a warm coat. 3. Other lessons, as well as those already mentioned, teach the laws of Nature such as those marking order and regularity in the natural world. 4. Even streams and pebbles supply abundant opportunities for **investigation,** which is the foundational principle of all Nature-study. 5. Lessons, too, there are that show the child, in a special way, **how Nature may be made subservient to the purposes of man.** These are lessons on vapor, frost, rain, etc. 6. Lessons on the **human body and its care,** such as sleeping, waking, eating, etc., are, perhaps, as important as any of Nature's many phases to be emphasized.

IV.—Every member of the class should be encouraged interest himself in some particular phase of Nature-dy, and when the class, as a whole, is not ready to al with that particular part, enough information should given to the individual child to aid him in satisfying curiosity for the time. Individual strivings should vays be encouraged, never blunted. Should any ild show marked ability in any particular direction, s should be carefully noted and such assistance and couragement given him as will enable him to continue investigations. The amount of time spent every ek in investigating the different topics must be left the judgment of the teacher. Phenological observa-ns and observations on the weather should be made ery day. Owing to the variety of the child's observa-ns outside of school, the teacher may find it convenient have several topics before him at one time for study. -day opportunities may be presented for studying the n. To-morrow there may be an opportunity, which ay not occur again for several days, of watching the e. Knowing the field before him, the teacher has no cuse for not taking advantage of these opportunities.

CHAPTER VII.

RELATION TO OTHER SCHOOL SUBJECTS.

> All Nature is but art, unknown to thee ;
> All chance, direction, which thou canst not see ;
> . . . .
> All are but parts of one stupendous whole,
> Whose body Nature is, and God the soul.
>
> —*Pope.*

READING.—Since it is true that no one subject in the inary grade can exclude the others—each is in all and is in each—yet certain subjects are more closely lated than are others. *Nature-Lessons* and *Reading-*

Lessons have a special relation to each other. Natur lessons open the way for the teaching of reading b increasing the intelligence of the child, and by furnishin data on which to build reading-lessons. Reading im presses the information gathered by presenting it in new form.

In the first stages the Nature-lessons suggest the kin of reading-lessons. The child has had a Nature-lesso on leaves. He has had certain thoughts about them These thoughts differ from those of his companions. T draw skilfully these different thoughts from the child an to express them in writing in such a way as to make th child realize that the written or the printed page is th thought of some one expressed, is really to conquer th first great difficulty met with in teaching reading. The again, suppose the child has studied the life history the squirrel or of the thistle; he is prepared to rea intelligently the history of any of the other rodents, that of any of the other members of the thistle famil

As the child advances sufficiently to become to certain extent an independent reader, and to have certain stock of information to draw upon, the readin may suggest the Nature-lessons. For example, the chi who has been reading a myth or a child-like poem, such a story as Hiawatha must, in order to apprecia any of these, come to the world of Nature to have th ideas contained in them vivified. Sometimes pictur and stories appealing to the imagination do much throw light upon a reading-lesson, but they are after a poor substitutes for Nature. Great truths of Natur often difficult for the child to understand, become qui clear to him when presented in a bright, attractive Natur story. Thus, by having a better appreciation of th things of Nature, he is incited to further observation an has his *appetite for investigation* still further increased.

That the character of a child or youth is weakened strengthened according to the kind of books he read is a fact that requires no proof. Yet few teachers, wi

knowledge of this fact, and also with the knowledge
t a taste for good reading at a very early age can
implanted, are as careful as they should be of the
le reading-lessons they prepare, from time to time,
their classes, or of the kind of prepared lessons they
ce before them. From the beginning, the reading-
sons should not only be such as to interest the
ld, but they should also be such as to instruct him.
ey should open his eyes to the life around him, in
der that he may profit more from life. In fact, they
ould embody the great truths of life he sees exempli-
d in the common things around him. That the eye
s only what it has the power to bring with it, is as
e in reading as in anything else, and especially is this
e with little children. The subject for reading must
some way or other be related to the child's own experi-
ce, or it must be within the range of his imagination.

A suitable Nature-story for a child must be written in
h a way as both to instruct and to please. In addition
being true, t must always keep the beautiful and the
monious in Nature in the foreground. It must give
imagination healthful play, while behind all it should
k to illustrate some great truth which the child cannot
to understand, because he will meet it on his own
ound and it will speak to him in his own language.

COMPOSITION.—In the average school, the subject of
nposition is a difficult one. The proper teaching of
ture will open up many avenues through which the
ld can be led in a gradual and natural way to thought-
pression in writing. A full soul always longs to find
pression, and it does so most frequently through
rds. If the ideas are clear and definite, the words
nbolizing them will be intelligible and the written
pression will be almost as easy for the child as the
al one.

GEOGRAPHY.—Whether considered from a physical
a commercial standpoint, the principles of Geography
pend upon the laws of Nature. The laws, for instance,

dealing with the great slopes—primary and secondary
are the keys which open this study, not as isolated fac
but as a science, before the child. On them depe
the great equalizing force of rainfalls. They also g
direction to the drainage, hence to a certain extent reg
late temperature and soil. On temperature and soil d
pend animal and vegetable life. Man depends upon t
animal and the vegetable world for his life. His occ
pation, and, to a great extent, his life history are det
mined by his environment. In teaching Nature, h
easy it is for the teacher to get at these root princip
at once. No special excursion is required. Obser
tions on the general surroundings, where any spec
observations are being made, and on the natural phen
mena at this particular time and season, should be co
sidered an important part of the work. For the child
become fully acquainted with his immediate neighbo
hood is really to be in possession of the means to beco
acquainted with the whole earth. The part always co
tains the whole.

> "The half-moon's silver arc its perfect circle tells,
> The limitless within art's bounded outlines dwells."

This acquaintance, however formed through t
senses, must be such as will enable the pupil to fo
clear concepts—clear mental pictures—of the differe
forms of land and water he has seen; then throu
the imagination he will form correct ideas of land a
water he has not seen. During these observatio
too, his eyes should be open to the effects whi
rain, frost, snow, etc., produce in the way of prepari
soil for the support of life in his own little neig
bourhood. Then through imagination he will understa
their power and effect in lands far away. The cle
percepts of a neighbouring little brook, studied
actual observation in all its particulars, form the ba
for understanding, say, the great Niagara. No amou
of book knowledge can prepare the child for su
conceptions. Preparation must come from actual conta

h the thing to be studied. Thus we see Nature-study d Geography must go hand in hand. In fact, in the ginning, they are the same thing. Geography studied ough Nature not only gives a basis for reasoning, but o provides subjects for expression. Hills, valleys, nds can be moulded in the sand. Outlines of them n be made on the blackboard and on paper.

MANUAL TRAINING.—So closely are Nature-study d manual training connected that the one blends most urally into the other; indeed, at times, they are the unterpart of each other, and must work hand in hand. oking at manual training from the educator's point of w, its object is far other than that of industrial training, t is, training to prepare the child for gaining a liveli- od. Manual training is not, as in technical schools, a eparation for gaining a living, with little thought of its lture value; it is a *means to an end*, and that end is the *ucation* of the *whole child*. It is only one factor in the ny factors of his education. It aims at the training of e mind through a series of exercises involving the e of tools. The materials upon which these tools are be used are carefully selected and the exercises logi- lly arranged. They are carefully graded in difficulty. e muscular movements are definite, hence the mental ction is definite also. Thus manual training is one the subdivisions of Nature-study whose central idea is give power over environment, and whose special duty to increase the power of self-realization by expression.

Manual training schools recognize as, perhaps, no er schools do, the importance of preparing the child self-expression through making, and for the training his intelligence while making. In order to do this, er subjects of necessity must have a place. Perhaps e most important of these subjects, and that most sely connected with manual training, is Nature-study.

Knowing the *object of manual training*, and the *mean- of Nature-study, the relation* of the two is *self-evident.* e senses can be trained only through environment.

The child's environment is the world of Nature. Natu study trains the hand and eye by encouraging the ch to record, through drawing, moulding, modelling, etc., t form and shape of different natural objects common to environment. Such training is surely the best kind preparation for manual training through the use of too and should precede graded exercises. If Nature-stu is neglected, there must certainly be a gap in the ed cation of the child. Nature-study fills a place that nothi else can. *Nature-study* also *blends* with *manual traini* by way of *making the child an intelligent workman.* knows well the history of the wood he carves, turns a planes. He looks at it with a seeing eye. It means mu more to him than dead material upon which he is to wo So with the metal and the clay. Then, too, proporti balance, beauty of curve, so necessary in such wo are all familiar to him through his Nature-stud Manual training is conducive to the health and t mental development of the child. He enjoys such trai ing, and will enjoy it very much more if, as the crowni work of Nature, he has through its study learned se knowledge, self-reverence and self-control. It is on when knowledge and experience join hands that we c expect the highest possible results.

AGRICULTURE.—No one can be an agriculturist in t true sense of the word without being an earnest stude of Nature; yet one can be a student of Nature lo before he is capable of becoming an agriculturist. children are taught to study Nature, they will not on be prepared when they are old enough to study agricu ture as a science, but farm-labour will assume a ne aspect; they will have more respect for it—it will n longer appear to them as a life of dull drudgery, but w have attractions equal to those of any other calling.

CHAPTER VIII.

NATURE-STUDY AND SELF-EXPRESSION.

The great Creator condescends to write
In beams of inextinguishable light
His names of wisdom, goodness, power and love,
On all that blooms below or shines above;
To catch the wandering notice of mankind
And teach the world, if not perversely blind,
His gracious attributes, and prove the share
His offspring hold in His paternal care.

—*Cowper.*

Vords are too often regarded as the only means of -expression. The teacher forgets that the other means elf-expression are important. They oftentimes give t to the natural bent of the child and point him n early age to the path on which lies his life work. tures, diagrams, illustrative blackboard sketches, dels, painting, each has its own particular place. pression by means of the spoken or written word, ortant as it is, is often unduly emphasized, and ure-lessons have been given, at times, for the sole pose of furnishing subjects for word expression. ly the field of Nature, as no other field, gives scope this kind of expression, but ideas even here should be forced upon the child in order to teach him to k or to write. The child should speak and write use he has ideas to express. The fuller and clearer e ideas the better will be the expression. Expres-, let it take what form it may, should not be the lt of the stimulus supplied by the teacher alone, but ld follow as the natural consequence of the work g done, and should go hand in hand with the ect of study itself.

ut not only has the tendency been to emphasize un- the spoken and written word, but it has also been glect other means of expression to such an extent in some schools their place in the training of the l has scarcely been recognized at all. Few teachers

even to-day are fully alive to the fact that their skill teaching Nature and subjects related to it depends t great extent on their knowledge of how to use differ kinds of expression to illustrate the particular phas truth being taught. To cultivate this many-sided po should be the aim from the beginning. The id gathered from each Nature-lesson should be expres in as many different ways as possible. Expressio the real test of knowledge.

Supposing the Nature-lesson be on the different ki of roots, which are very suitable for first lessons as t show variation of form ; these are examined and tal about. They should be modelled ; sketches should made of them on the blackboard and on paper ; t they should be painted. If the child is sufficiently vanced he should state in writing certain facts about th

MODELLING.—By examining a thing with a v to modelling, the senses of touch and sight are ca into play. Through sight we generally know the f of an object as well as the nature of its surface. T knowledge, however, is really the result of the fu of the products of sight with the remembered ima of touch. Constant association has established mental habit, by which the sensations through one medium complete themselves by reviving ima previously received through means of the other. sight may deceive owing to the effect of light and sh upon form. A thing may appear rough or smooth child if he depends on his sight alone, or if he has had enough practice to give distinctiveness to prod already in mind. By way of judging the clearnes the child's percepts of the form of an object, ask to model it without looking at it. Much discovered the child in his Nature-lessons on fruits, roots, lea flowers, fish, birds, etc., can be well expressed thro modelling. Each form has a charm peculiar to itsel the child. Only the simpler forms should be attem in the elementary classes.

odelling in sand is an excellent means of expres-. From Nature, the child has learned the different s of land and water. By means of sand he can ess these forms. He can also show their relative ion. Skill in expressing forms through sand-model- depends to a great extent on accuracy of seeing.

RAWING.—Nature-study and drawing are so closely ed that it is impossible to teach the one without other. Through Nature-study the child gets ideas e things about him; through drawing he expresses houghts and ideas gathered. Thus thought and ession are united, and he gains therefrom accuracy rception. But this is not the only gain, for the accurate the perception, the more power the pupil have to express himself in both spoken and written uage.

om the first, drawing as a means of thought expres- should be emphasized. If the child knows that it ssible for him to express in drawing certain facts t the object being studied, his interest in it will be greater than otherwise. He will think more about nd his observations concerning it will be much er. In fact, by trying to express his thoughts rially, his eyes will be opened, as they could not wise have been, to the perception and variation of , to the beauty, the symmetry and the proportion where in Nature. Then, again, it is impossible ach drawing, in the true sense, without coming to re for subjects and for guidance. Nature has ys been the true artist's guide.

awing, as a means of thought-expression, can be tably taught to young children before writing. A will draw the outline of a fish or of a butterfly long e he can write its name. This fact is yet far being realized, and pupils are kept hours trying rm letters and words, with a view to expressing ght in writing, instead of spending at least a part of

this time in free-hand and arm movements, practis lines and curves, in order to gain control of the musc with a view to expression through drawing. Whene it is at all possible, the child should be required to *d from Nature;* even moving objects in Nature will, a the child has had considerable practice, not be diffi to draw. Movement changes position and appeara but not the proportion.

The *first natural objects* selected for drawing sh be as simple as possible. They should be such as be drawn with a few lines. The following might mentioned as good examples: beaks of birds, butter fish, leaves, simple flowers.

In drawing, as in Nature-study, type-forms sh be emphasized. They should be drawn in as m different positions as possible. For example: a might be drawn in a sitting posture, in a standing ture, swimming, in the act of taking food from ground. Botanical forms, particularly flowers, themselves most readily to simple drawings in diffe positions. The drawing of typical forms should repeated until the child can readily draw them memory. Such drawing sharpens the observation.

OUTLINE AND COLOUR.—In connection with ou use colour, and show how form can be develope means of colour. The different forms of roots ma brought out by means of shading. A flat disk ma made to appear spherical in the same way. A simple picture in outline can be brought out in stri relief by colour. Flowers, leaves and fruits have a attraction to the child when he has attempted to expression to his thoughts about them through pain Children in the primary grade can sometimes ex more with their brush, or with a very soft, l coloured crayon, than they can in words.

MAKING is one of the simplest forms of expression, too, which receives the least attention. Possibly the

for this is the fact that there is so much inconvenience obtaining the material. This mode of expression ld be encouraged at every possible opportunity, as ing furnishes a standard to the teacher of the nature e concept of the pupil. Making, as a means of self-ession, had a good start in the kindergarten, and ld be continued. 1. Patterns of simple garments t be outlined on the blackboard. Paper models be cut in pasteboard, and will serve as a guide for hild. After the different parts of the garment have cut in paper, the child may paste them together. le patterns, correctly cut, can be obtained from any on book. 2. Making paper flowers in tissue paper, firm pasteboard for models of the different parts e flower, is a good exercise. Always copy from the flower. After the pattern has been cut it may be as a guide in modelling. By placing the pattern in eometric form to which it belongs, the child can learn how to conventionalize leaves and flowers. t birds, flowers, animals from magazines or papers; each picture on cardboard, and cut out the form. these patterns on coarse white paper; outline, cut ollowing the outline; then color (as true to Nature ssible) with oiled crayons. This is both a profitable nteresting exercise in coloring for children.

ere are other means of expression which are more y related to the emotions of the child. These *acial expression and tone of voice*. So important ese two kinds of expression that the teacher should s be on the alert for the best way of training them. e-study, touching, as it does, the soul of the child, s opportunities unknown in any other field for this ng.

cultivate tone of voice encourage the child to imi-I) *sounds made by animals.* Give practice at first ose in which there is a marked difference, and in he child will be able to imitate, at least to a certain t, the more difficult sounds, such as bird-notes.

The following are suggestive :—The mew of the the bow-wow of the dog ; the baa-baa of the lamb ; quack of the duck ; the cluck of the hen ; the caw of crow.

(II) Also imitate the sounds made by the ani above mentioned under different conditions, and acc pany with suitable facial expression. For example imitate the sound made by an angry cat ; (2) by a calling her kittens ; (3) the reply made by the kitt (4) the cat asking for food.

III. Imitate such sounds as the following :—So made by the wind, the rain, the steam engine, the kettle singing.

IV. Ask the child to imitate the actions and f expression of people as he imagines them to be u the circumstances as stated by the teacher.

(*a*) Baby is asleep. Mamma raises her finger as say, " Hush, do not waken baby ! "

(*b*) A child is peeping at a bird's nest in a bush a taller than himself. He is afraid he will frighten mother bird.

(*c*) A little girl sees a snake in the grass. She a sudden start.

CHAPTER IX.

EQUIPMENT FOR NATURE-STUDY.

> **And Nature holds in wood and field**
> **Her thousand sunlit censers still ;**
> **To spells of flowers and shrub we yield**
> **Against or with our will.**
>
> —*Whi*

Teachers who realize the inexhaustible deligh Nature, will be convinced that to establish a relatio with Nature ought to be as much a part of every e tion as to teach the rudiments of formal know

t because of their lack of knowledge of the different ences, they cast the thought of attempting such a urse aside as altogether impracticable. They are not sponsible, they think, for either their lack of training their environment. So they helplessly follow the well-aten paths of the past, and envy those who can travel the new road shaded with trees and strewn with wers. No teacher need find himself in this helpless ndition. With the desire to know Nature, will come en eyes, and, as a consequence, help from everything out him. Even the city streets, which before seemed him barren, will now teem with the products of Nature, d may be made to serve the purpose of training the serving powers of the pupils. A teacher with a practi-turn, who comprehends the importance of this work, d is imbued with the determination so to equip himself t he may inspire his pupils, will do far more *in king them investigate* than one who possesses, it may a knowledge of all the sciences, yet who is content do the work of the school-room as it has been usually ne in the past. Sometimes the greater the knowledge, less the power. After all, it is the personality of teacher that counts most. Some one has calculated t the efficiency of school work depends upon physical uipment to the extent of only fifteen per cent., and on the personality of the teacher to eighty-five per nt. It is character, individuality, spirituality that give personality. But though this power counts most, certain equipment is necessary in order that the cher may make his personality felt. It is impossible establish a relationship with Nature without bringing child into direct contact with Nature.

I thought the sparrow's note from heaven,
Singing at dawn on the alder bough;
I brought him home, in his nest, at even;
He sings the song, but it cheers not now,
For I did not bring home the river and sky;—
He sang to my ear,—they sang to my eye.
The delicate shells lay on the shore;
The bubbles of the latest wave

Fresh pearls to their enamel gave,
And the bellowing of the savage sea
Greeted their safe escape to me.
I wiped away the weeds and foam,
I fetched my sea-born treasures home;
But the poor, unsightly, noisome things
Had left their beauty on the shore
With the sun and the sand and the wild uproar.

—*Emerson*

Many experiments have been tried to discover t most practical way of doing this. Whole classes children with their teachers were sent to public pa and gardens for observations. This was found to g but very superficial training; they were not allowed break a single twig nor to pluck even the small flower. Neither could they be sent often enough watch the plants and flowers developing. Such e periments, in some centres of education, led in ti to the establishment of *school-gardens*. The nearn of the school-garden was found to be one of its m valuable advantages. In these gardens, no attempt been made to arrange the plants in ornamental be since they cannot be studied so well in that arran ment.

In many places in Europe not only have school-g dens been established, but school authorities have aim to impart clear ideas of horticulture and related occu tions by various uses of land connected with the scho The child is instructed in ploughing, in hoeing, in fer izing the land; in pruning and grafting trees; in hivi bees, in raising silkworms, etc.

In Sweden, as long ago as 1871, twenty-two thousa children received instruction in horticulture and tr planting, and each of two thousand schools had a pi of land under cultivation, varying from one to twe acres. Since 1877 the public schools of Berlin have b regularly supplied with plants for study every we The gardens in connection with these schools are a considerable distance from the school. The child

dom visit them. The teachers, however, consult h the gardener as to what ought to be sown and nted. During the summer, at about six o'clock in morning, the gardener from the school-garden starts with a wagon loaded with cuttings, packed and elled, for the different schools. Each elementary ool receives four different species every week. The ly newspapers announce what plants and cuttings y be expected. When the garden is at a distance m the school, the pupils suffer the following dis- vantages, viz., they cannot watch the growing plant, d the varying effects of soil, light, heat and moisture them. Neither can they watch the habits and work butterflies, beetles, ants, and such insects as are ays found where plants are growing.

In 1890, in Austria, there were nearly eight thousand ool-gardens. The public school law there demands t in every school, according to the circumstances of community, a school-garden be established. The cher is also required to be skilled in giving instruc- ns not only in all that relates to the soil, but also in tural history.

In France, no one who is not qualified to give practi- instruction in cultivating the ordinary products of garden can be appointed master of an elementary ool.

In the spring of 1891 a school-garden was established connection with the Boston Grammar School. Since t time marked progress in school-gardening has been de in many parts of the United States.

In every country where the school-garden has been en a fair test, educators have come to the following nclusions:—The structure, uses and functions of plants so varied and so interesting that the best material, the whole, for the teaching of elementary science, or Nature-study, is found in the vegetable world. Then, , the cycle of plant life from seed to seed furnishes a

lesson in biology that is unsurpassed in value. Liv plants are necessarily connected with earth, water, air well as with various forms of animal life—birds, insa worms and slugs ; hence the chiid sees the correlat of things under the best conditions.

Public sentiment in favour of Nature-study is grow so rapidly that the necessary equipment for this wor at the hand of almost every teacher. Cornell Univers College of Agriculture issues a Junior Naturalist mont for children, while the Bureau of Nature-study will g the teacher of the state any suggestions he may des by way of helping him on with his work. In Cana public sentiment in this line is growing rapidly. T Agricultural College at Guelph, and the Entomologi Society of Ontario have extended help to the teacher suggesting topics and giving type-lessons.

The equipment for the work will depend greatly the power with which this sentiment takes hold of sch authorities. Books on Nature should form a part of school library. There should be a few magnifying len and a compound microscope in every school. The len are to be used constantly by the children. The teac should use the microscope that he may see clearly h to guide his classes. The microscope should be u occasionally by the children to excite their wonder interest.

PART II.

LIFE-HISTORIES AND SUGGESTIVE LESSONS.

THE CABBAGE-BUTTERFLY.

The study of this insect may begin with the egg of the butterfly, the rva, the chrysalis, or with the butterfly itself.

Butterflies may be caught and put into an empty hat-box, or small barrel ith one end knocked out. Put in some cabbage-leaves or leaves of any f the cruciferous family. The butterfly will deposit its eggs on these leaves. ut also some chips and twigs in the box. Cover the box with cheese-cloth r fly-netting. As soon as the grub appears renew the leaves. See that esh leaves are put in from day to day.

In due time the pupal stage will be reached, the insect will attach itself a twig or side of the box, and pupate in the form called a chrysalis. If ept in a cool place the butterfly will appear. The different changes can e closely watched from day to day by the children.

A.

I. The Egg.

Make observations in a cabbage-patch, also on the insects as preserved n the box.

Why do so many butterflies visit the cabbage-patch?

On which side of the leaf does the butterfly deposit its gg?

Why do the eggs not fall off the leaves?

Are the eggs in clusters, or are they scattered here and here?

Does this butterfly ever deposit its eggs on any other ind of plant than the cabbage-plant?

Examine the leaves of radish, turnip, mignonette, and other vegetables.

Make a drawing of one of these eggs.

Has it a shell?

What color is it?

Is its color any protection to it?

Investigate and report.

Do you know of anything else in Nature that is pro-tected by its color?

Note 1.

Draw a leaf showing several eggs upon it.

II. The Larva.

How did the larva get out of the egg?

Describe this larva. Draw it.

Note 3.

Could you tell that a worm or some other living thing had visited these leaves?

Direct attention, if necessary, to the holes and ragged edges of the leaves.

Do they eat the leaf-tissue or do they suck the sap from it?

Make observations and report.

Describe the way in which this larva eats.

Note 4.

Why did the larva make these holes?

Examine leaves visited by other larvæ and determine whether they treat them like the cabbage-worm?

Describe the way the larva crawls. Into how many parts is its body divided?

Introduce the term *segment* in conversation in such a way that the children will know what it means.

How many legs has this larva?

Do all the legs look alike?

Introduce the term *proleg*.

Note 5.

On what part of the body are the true legs?

On what part of the body are the prolegs?

How many segments are without legs?

Dust some insect powder on the larvæ; watch the result.

What has caused the death of the larvæ?

Would sprinkling the powder on a cat or dog be likely to cause death? Why not?

Draw attention to the small openings which may be seen in large cabbage-[la]rvæ along each side of the abdomen, in the same line as the yellowish [spot]s. These openings are the ends of tubes that supply air.

If these breathing-holes become clogged what will [ha]ppen to the larva?

Describe the way in which the larva breathes.

How may gardeners prevent the destruction of their [ca]bbage-plants by these larvæ?

Observe the sloughs in the box where the larvæ are [co]nfined. What are these?

Why does the larva cast its skin?

Introduce the term *molts.*

Try to find how many times each larva molts.

III. The Pupa, sometimes called the Chrysalis.

In about three weeks after the larva appears there will be indications [tha]t another change is about to take place. It refuses to eat and is slug-[gis]h. It is now about an inch long.

Describe the change in the form of the larva.

Pupils have been watching the breeding-box from day to day, and have [no]ted the pupating among the leaves.

Describe the larva in its new form.

Introduce the terms *chrysalis, chrysalids, pupa, pupæ.*

How long is this chrysalis?

How is this chrysalis suspended?

Where did the larva get the thread by which it [at]tached itself to the twig?

Note 6.

What is the color of the chrysalis?

Is the case thick or thin? Can you see any definite [fo]rm in it?

Note 7.

Draw the pupa-case.

Open a pupa-case.

Observe closely to see whether the chrysalis changes form.

In about eleven days the chrysalis-butterfly will emerge as a perfect [but]terfly.

Examine the empty case.

Describe the butterfly immediately after its emergenc from the chrysalis stage.

Note 8.

What are the different stages through which it ha passed?

Draw the butterfly in different positions.

Into how many parts is the body of this new form divided?

How many wings has it?

How many legs has it?

How many antennæ?

How many eyes?

After study of the butterfly show why it is a true insect. Make compari sons.

IV. The Butterfly.

Close observation on the habits and structure of the butterfly should be continued from this point, unless the teacher begins to study the insect as in B.

V. Comparison.

Compare its habits and structure with those of other butterflies and moths.

NOTE 1.—Many worms, insects, birds and reptiles are protected by their color.

NOTE 2.—Eggs are deposited also on leaves of rape and other cruci ferous plants.

NOTE 3.—If observations cannot conveniently be made out of doors, have a supply of cabbage-larvæ on hand, and a piece of partially-eaten leaf. A leaf, with a larva at work upon it, should be in each child's hand.

NOTE 4.—These larvæ eat the leaf-tissue.

NOTE 5.—The body of larva. (1) The head, with its eyes and biting mouth parts—jaws (mandibles); (2) the segments of remaining parts of the body, (*a*) the three pairs of true legs on the first three segments; (*b*) the segments following, with no legs; (*c*) the segments bearing short, fleshy, soft legs (prolegs).

NOTE 6.—In the body of the larvæ are two long tubes which contain a sticky fluid. The tubes end in the middle of the lower lip. As soon as

fluid comes to the air it hardens something in the way in which sugar is boiling to the point when it ropes.

NOTE 7.—On close examination wings like short pads can be seen; legs coiled tongue can also be fairly well recognized within the case.

NOTE 8.—Children have frequently been fortunate enough to see a butterfly at such time. Its wings are short and wrinkled. It remains suspended from some object until they expand and dry. It is then able to

B.

I. The Butterfly.

Butterfly first observed among the flowers.

Try to obtain a few specimens; kill them by placing them in a poison-jar. Such jars are made by placing in them cotton-batting saturated with chloroform or carbon bisulphide or putting in one or more lumps of cyanide of potassium. The last mentioned poison is frequently embedded in plaster of Paris in the bottom of the jar. Pin them in order to be able to make closer observations. Also collect specimens for the breeding-cage. While the eggs are developing study the butterfly as a whole.

What were the butterflies doing among the flowers?

Upon which flowers did you see these white butterflies resting?

Watch and report. Note a.

What part of the flower does it use for food?

How does it get the nectar out of the flower?

Try to observe the butterfly on the flower.

II. The Tongue.

Examine the pinned insect. Do you see any part of the head that might help the insect to get the nectar?

Put a straw in a bottle containing water and allow the children to suck some.

Describe the tongue.

This question could not be answered without the aid of a microscope. If the school is not supplied with one the teacher, at this point, may have to give information.

Note 3.

The teacher may make a sketch of the tongue on the blackboard.

III. The Antennæ.

Describe the antennæ.

We can tell a butterfly from a moth by the antennæ (singular antenna). The moth has no knobs on its antennæ.

Of what use are the antennæ to the butterfly?

Note 4.

IV. The Eyes.

Where are the eyes of the butterfly situated?

Compared with the size of the insect are they large or small?

How many eyes has the butterfly?

Direct attention to the top of the head.

Draw the head of a butterfly, and mark the position of the eyes.

Note 5.

V. The Legs.

How many legs has the butterfly?

Did you ever see a butterfly with any other number?

Watch and report.

How are the legs placed?

Does a butterfly use its legs in the same way as a fly?

Watch closely how it uses its legs and report.

Into how many parts is each leg divided?

Draw a leg.

Draw the body of the butterfly, and show the position of the legs.

VI. The Wings.

How many wings has the butterfly?

How are these wings placed?

Are they all the same size?

Describe the appearance of the wing after it has been rubbed.

What has come off the wing?

The powder is really little scales. These scales give the color to the wing. They also give it its velvet-like appearance.

In what way do these wings differ from those of a fly?

Examine and report.

How does a butterfly hold its wings when it is re… a flower?

Draw it in this position.

VII. The Haunts.

Do butterflies frequent other parts of plants than the …wers?

What were they doing in the vegetable-garden?

Proceed to examine the egg, larva, chrysalis, as outlined in (A).

VIII. Cocoons.

Capture larvæ; put them in a breeding-cage and feed …m with the leaves of the plant on which they were …nd until they pupate or spin up into cocoons.

Teach the term *cocoon*.

Keep the cocoons and observe them until the trans…mations are completed, then dissect the empty case.

IX. The Breeding-Cage.

Procure an ordinary store-box. Provide a lid made …m a frame large enough to fit the box, and stretch …ze over the opening in the frame. Set jars or bottles …h the food-plant in the box, stuffing something around … neck of the jar to prevent the larvæ accidentally …ing into the water.

…OTE 1.—Sometimes butterflies become torpid and remain in cracks …ng the winter. Others form chrysalids or cocoons late in the autumn. …ers migrate.

…OTE 2.—The cabbage-butterfly is not particular in its choice of flower. …sits the dandelion, the yarrow, the thistle, and indeed all the common …oms.

…OTE 3.—The butterfly has a much modified mouth, *i.e.*, as compared … its larval stage. The tongue or sucker is divided into two parts by a …down the middle. Each part is grooved. These parts are covered … tiny hairs and the two parts by the interlacing of the hairs form a tube. …imes the hairs become covered with a sticky substance; the butterfly …s them with his front-legs.

…OTE 4.—All the uses of the antennæ are not known. Th… …nses of …, hearing and smell may reside in them. If they are cu… off the …t does not fly.

…OTE 5.—The compound-eye might be described by the teacher, and a …h made showing the facets.

THE CECROPIA EMPEROR-MOTH.

The caterpillar of this moth is a general feeder. The apple-tree is a favorite with it but it is also found feeding on various other fruit and shade-trees.

Collect a number of larvæ, place them in the breeding cage and have the pupils feed them until they form the cocoon.

Describe the cocoon, its shape, color, length and breadth.

Note how it is attached to the twig.

Teach the term *cocoon.*

Examine an empty cocoon.

Describe the outer wall.

Remove this and describe what is underneath.

Remove the second covering and describe the inner cocoon.

What are the advantages of such an arrangement of the coverings?

Compare the way in which the fibres are woven at the small and large ends.

Open a tenanted cocoon.

Describe what it contains.

Teach the term *chrysalis.*

Watch a moth escaping from the cocoon and describe what is taking place.

At which end of the cocoon does it escape?

How are the fibres softened to allow the moth to push the threads aside?

What advantage to the insect is it to have the fibres of one end more loosely woven than at the other end?

Which part of the moth is first protruded?

Describe how little by little the entire insect escapes from the cocoon.

Describe the insect in its first appearance.

Describe it after its wings are dry.

Compare the insect with the cabbage-butterfly and tinguish a moth from a butterfly.

The larvæ of other insects should be collected and ated in a similar way to those of the cecropia peror-moth.

Thus those of the promethea-moth may be collected the wild cherry-tree and those of the polyphemus-th on plum-trees, the woodbine, grapevines and lilac-hes. Observe how the cocoons are fixed on the leaf in the case of the former how the leaf is fixed to the nch.

THE BEE.

order to get the full nefit from the study of "The Bee" one or beehives must be accessible to visits by the pupils. Mounted mens of bees are also needed.

The Bee among Flowers.

Discover what it is doing. Does it rest on the vers? Note the kind and the color of the flowers ted, and the order in which they are visited. Make a of flowers visited by bees.

Imitate the sound made by the bee. When does bee make this sound? Compare it with the sounds le by (*a*) the fly, (*b*) the grasshopper. Discover how sound is produced in each case.

Describe the action of the bee as it approaches dif-nt flowers. With what is its body frequently covered? s the bee make any use of this powder for itself? s it lose any of that gathered? Observe the bee as oves from flower to flower. Then follow it home and rve its actions there. Infer the use of the bee to flower.

Examine the leg of a bee. Describe the basket, the h, the foot. Tell the use the bee makes of each of e parts.

5. Does the bee get anything else out of the flo
besides pollen?

Taste the lower ends of the different petals, especially of the flowers
quented by the bee.

6. Does the bee eat all the honey it gathers? Wa
it as it goes to and from the hive. Infer the reason
its activity, and discover how it carries the honey.

7. Observe the bee on a flower too small for it
enter. Infer from its actions how it uses its tong
With a lens observe the little scales between the s
ments of the abdomen. If possible observe how
plucks out these scales. What use does it make
them?

Introduce the term *wax*.

Where does the bee get wax?

There may be no correct answer to this question, in which case
teacher must instruct.

8. Does the bee ever visit the blossoms of fruit-tre
(Observe and report.) At what time of the day do
find the greatest number of bees at work among flow
Infer the reason of this.

(1) Draw the different parts of its body.

(2) Draw the bee on a flower.

(3) Model the bee in clay:

(*a*) Abdomen (have mounted specimen as model). (*b*) Chest (mar
three rings). (*c*) Head. (*d*) Legs (in joints). (*e*) Cut wings in p
and pin with tiny pins. (*f*) Eyes.

Give the term *insect* and its meaning. Infer why the bee is call
insect.

II. The Bee at Home.

If possible have a glass plate put in one side of a h

1. Observe any difference in size of the bees; in
shape of their bodies; in their legs. Infer the reason
this difference.

Introduce the terms *queens*, *drones*, and *workers*.

2. Draw a bee of each kind and discover the partic
kind of work it has to do. Infer the advantage (a

bee, (*b*) to man, from this division of labor in the bee's household.

3. Observe the comparative number of each kind of bees in a hive. Infer the advantage of having different kinds of bees in a hive.

4. In the autumn how are the drones treated by the other bees in the hive?

5. Observe the working-bee building the cells. Describe how it lays the sheets of wax, how it gets the wax off its body; the shape of the cells; how the single partition serves for the double boxes and infer from this the skill of the bee and its intelligence in economizing time and labor.

Draw several of these cells side by side. Teach the name *honeycomb*.

6. What advantage is to be gained for the bee by providing it with honeycomb?

7. Observe the different uses the bee makes of these cells. Of what use to the bee is the honey and pollen stored in the cells. Teach the name *bee-bread*.

8. Observe the work of the mother or queen-bee. Describe an egg. Note the way in which the working-bees treat the mother-bee. Describe the appearance of the cells after the eggs have been deposited.

9. Examine several larvæ. Infer the reason for the difference in the appearance. Describe the treatment given to the different kinds of larvæ by the nurse-bees.

10. Observe the change that takes place in the larvæ. Describe the young bee as it comes out of the cell. How do the working-bees treat it? Where does it get its food at first?

11. Describe the way in which the queen-bee treats the "young queen," and how this new queen is protected. If the young queen dies how do the bees act?

12. Observe the way in which bees treat such foreigners as caterpillars, moths, flies and slugs.

III. Bees leaving the Old Home.

1. Describe the actions of the mother-queen when s hears the first song of the young queen; observe h attempts to use her sting in order to kill this quee note how she is defeated by the workers. Observe h flight from home followed by a number of bees; th appearance as they hang together in a bunch on a vine, branch.

2. Observe how the bee-owner treats these bees a note how actively they proceed to build a new home.

IV. The disturbed state of the Old Home.

1. Describe the actions of the workers to the n queen; the battle between the new queens shou more than one appear; the action of the working-be towards the fallen queens; and their loyalty to the n queen.

V. Other Suggestive Lessons.

1. Natural swarming. When? Why? How?

2. Artificial swarming. How to find the queen-bee.

3. Hiving. Comb formation. Brood and the stag of transition. Honey-collecting and storing. Lar other than that of the hive-bee to be found in the hi Wax-moth, an enemy.

4. Harvesting honey; quantity; how harvested.

5. Extracting honey (necessary apparatus), stori and packing honey.

6. Wintering bees. Keeping them fed, warm and d and free from all enemies.

THE GRASSHOPPER.

ITS STRUCTURE.

There is perhaps no other insect better adapted for the study of insect-cture than the grasshopper.

Besides making observations in the garden and in the field confine a few sshoppers in a wire cage improvised for the purpose. Make four frames n light slats; cover these with fly-netting, tack them together and cover top with the netting. Then take a shallow box containing a few inches arth. In it plant both long and short grasses. Over this box set the ne. Such a cage will allow free circulation of air which is absolutely essary to the life of the grasshopper.

I. General Description.

Describe the grasshopper, the shape of the body, number of its parts, how the head is set on the body, collar, the number of legs and wings—their position the body.

Teach the terms *thorax* and *abdomen*.

Observe the rings on the body. Count them and er their use.

II. Its Movements.

Observe the grasshopper *jumping*. Discover the part the body that gives it such power of movement.

III. Its Legs.

Describe the legs, their position and parts. Compare hind-legs with the front-legs with regard to size, shape d strength. Discover (1) how the hind-legs are fitted jumping, (2) how the front-legs are fitted for holding d climbing. Describe the feet. Draw (*a*) the hind-s, (*b*) the front-legs.

IV. Its Head.

Describe the head. Infer why it is so hard. Infer o why the eyes are so large. Discover the use of the ennæ.

V. Its Mouth.

Describe the mouth. Observe how it moves its jaws d its upper-lip. Discover the advantage of this move-nt.

VI. Its Neck.

Examine the neck. Infer why it is so soft and flexib Discover the use of the collar.

VII. Its Wings.

Discover why the outer pair of wings are so tou while the inner pair are so delicate. Describe the win and show how they are fitted in every way to the life the grasshopper. Compare them with the wings of butterfly.

Draw a grasshopper (1) with folded wings, (2) wi wings spread out for flying.

Compare its wings with those of a cricket.

VIII. Its Respiration.

Does the grasshopper breathe? What evidences ha you that it does breathe? Describe the expansion a contraction of the body. Using a lens observe t openings along the abdomen and thorax in a row on t side. How many of these openings are there? Sho them in the drawings you have made

Infer how insects are readily killed by covering th with oil or varnish.

Teach the terms *stigma* and *stigmata*.

Using the microscope observe the opening on t first abdominal segment. It is covered by a membra Discover if possible the use of this organ.

Observe the projections on some of the individu from the last segment of the abdomen. Discover possible the use of these.

Teach the term *ovipositor*.

Encourage pupils to observe to what extent t structure of the grasshopper agrees with that of t bee, the house-fly and the cricket, and to what exte it differs.

IX. Observations for Advanced Class.

I. Immerse a partially anæsthetized form in alcohol d observe that small bubbles of air are expelled from e stigmata. The contraction of the body will force bbles of air, which can readily be seen by the child, om the openings on the abdomen and thorax. Remove part of the body near these openings; with needles ke out and examine under a microscope the spirally-ound trachea.

II. Remove the crystalline covering of the compound-e and examine part of it under a microscope. Make awings representing the appearance. Explain that ch of the hexagonal spaces represents a single eye.

THE POTATO-BEETLE.

Into a box—an empty chalk-box will do—put an inch or two of soil. llect leaves with clusters of eggs; place them in the box; cover the top h a pane of glass. When the eggs hatch feed the larvæ with fresh leaves often as necessary.

Pupils should, if possible, study the beetle in the potato-tch.

I. The Egg.

On which side of the leaf are the eggs found?

Describe the cluster, also a single egg.

Into what do the eggs develop?

How long is it from the time the eggs are laid until ey hatch out?

II. The Larvæ.

Describe the larva.

How does the larva eat?

How long does the larval state continue?

When the larvæ are transformed what becomes of em?

III. The Pupa.

Describe the pupa.

How long does it continue in the pupal stage?

In what respects do the young beetle resemble the full grown one?

How long is it before it becomes a fully-develope potato-beetle?

Contrast the manner of eating of the fully-develope beetle with that of the larva.

IV. The Beetle.

Describe the beetle, its covering, its color and mark ings.

Point out the different parts of its body and describ the shape of each.

How many legs has it? On which part of the body are they situated?

Describe the head, eyes and jaws.

Compare its eyes with those of the grasshopper an the housefly.

Draw the head and eyes.

Describe the legs and feet.

Observe the movements of the beetle and show ho the legs are adapted to its walking movements.

Contrast its legs with those of the grasshopper.

Raise the hard wings of the body and discover th membranous wings.

To what part of the beetle are these wings attached?

Describe each pair of wings.

Observe how the beetle flies.

Infer the use of the hard wings.

Describe the under parts of the body.

Discover how the insect breathes.

Draw a fully-grown beetle in various positions.

Examine the mouth of a beetle.

Infer how it eats.

Compare its mouth with that of the butterfly and bee.

Observe the amount of leaf eaten.

Infer whether the potato-beetle is injurious or otherwise to the potato-plant.

Discover other kinds of beetles.

Note the different habits of each kind.

Make notes and drawings of each kind.

The beetle itself is in many respects the most interesting of all insects.

THE TRILLIUM.

I. The Home of the Trillium.

The teacher will show a trillium.

Direct class to find flowers like this for to-morrow's lesson (Notes 1 and 2).

If necessary the teacher should give such instruction as will enable the pupil to carry out this direction.

Each pupil has a plant in hand.

Describe the place where you collected your plant.

The answer will be followed by other questions, eliciting observations relating to such circumstances as situation, shade, soil, plant companions.

Describe the position in which the plant grew.

If necessary introduce and teach the term *erect*.

II. Parts of the Plant.

Show and describe the different parts which make the plant.

If necessary the teacher will give the terms, *root*, *root-stock*, *stem*, *leaves*, and *flower*.

III. Root and Root-stock.

Describe the underground parts.

Make a drawing of these parts.

How were these parts protected during the winter? Compare the undergound parts of the trillium with those of the buttercup, or clover.

Of what uses are the roots of the trillium to the plant?

Lead pupils to discover that the root with root-stock :—

(*a*) fixes the plant ;

(*b*) absorbs water and foods in solution ;

(*c*) receives from the green parts stores of food ;

(*d*) uses the stored food in the rapid development of green parts and flower in the following spring.

Have pupils mark the position of a trillium in the spring and examine the underground parts late in the autumn.

Compare the underground parts as seen in the autumn with those as observed in the spring. Account for the early blooming of the trillium.

IV. The Stem.

Describe the stem of the trillium. Draw it.

What are the uses of the root-stock?

Compare the stems of the trillium, maple, buttercup and geranium.

Introduce and teach the terms *herb* and *herbaceous*.

Using a branch of the maple of nearly equal diameter to the stem of the trillium note similarities and differences in bark and in the arrangement of the internal tissues.

Place some stems in water colored with red ink or a diamond dye, and describe what takes place. Note the parts where staining appears; and, by cutting a stem every fifteen minutes, the rapidity of the movement of the colored fluid.

V. The Leaves.

How many leaves has the trillium? How are they arranged on the stem?

Introduce and teach the term *whorls*.

On what part of the stem are they situated?

Observe trilliums forcing their way up through the ound and withered leaves.

Describe the arrangement of the leaves which enables em to come up through the ground.

Hold a leaf up to the light, and looking through it scribe the netted appearance

Introduce the terms *blade*, *vein* and *netted-veined*.

Draw a leaf.

Note 4.

VI. The Flower.

What is the color of the flower?

Who have flowers of a different color?

Trilliums of different colors may be brought to the class.

Is every part of the flower of the same color?

How many parts are white?

Draw one of these white parts.

Describe it.

Where convenient the child may cut these forms out of white paper.

Give the name *petal*.

Direct attention to the green parts of the flower.

Distinguish between the green leaves of the flower nd the green leaves of the stem.

How many green leaves has the flower?

Draw and describe a green flower-leaf.

Give the name sepal.

Compare sepal and petal.

Pupils should be questioned into discovering resemblances and differnces in color, shape, apex, and point of attachment.

Why is the sepal wide below and the petal wide bove?

It may be assumed that no right answer will be given this question. If ossible the teacher should lead the children to discover the reason. See Note 3.

Have you ever seen any living thing in the trillium?

If the pupils cannot answer, they should be required to make furth observations. When pupils know from observation that insects v flowers they may be led to infer that the more showy the flower t more easily it will be found by insects.

What is the use of the petals?

Introduce the term *corolla.*

What is the use of the green flower-leaves?

In this investigation use the term *calyx.*

Contrast the position of the calyx in the flower-bu with its position in the open flower.

Where was the insect when you saw it in the flower

What did it get there?

Pupils should be directed to discover that the insect visiting this flow becomes powdered with yellow dust.

Give the term *pollen.*

Discover where the insect got the pollen.

Give the term *anther.*

Make a drawing of the anther with its little stem.

Give the term *filament.*

The anther with the filament is called a *stamen.*

Mark filament, anther and stamen, on the drawing.

How many stamens are there?

Where are they attached?

What else beside calyx, corolla, and stamen do yo see in this flower?

With a sharp knife cut this part across where it i thickest.

Give the term *ovary.*

How many cavities do you find in the ovary?

The term *cavity* may need to be taught.

What do you find in these cavities.

Some day you will learn how these little white bodies become seeds. The pollen has a work to do in bringing about this result.

Can you infer from this how the insect serves the ...wer?

NOTE 1.—All pupils may not be able to find the flower, hence the ...cher should have material in reserve in bud and flower.

NOTE 2.—*The collecting of the flower by the child himself is an im...tant part of the lesson.*

NOTE 3.—One of the values of Nature-study is to show that everything ...y its form and life adapted to its function and environment.

NOTE 4.—The teacher must be careful not to ...ociate endogenous ...m-structure with reticulated venation of the le...; the ...enation of the ...lium is exceptional.

NOTE 5.—Children should be taught to be careful ... collecting ... nts ... to destroy them wantonly.

HORSE-CHESTNUT BUDS.

Begin observations on the horse-chestnut when ... and frui... are ...ing. The observers can then see the causes of two k...ds of ...s. They ... see also that the lenticels are not scars from external ...dies. The study ...bud-scale scars should be deferred until late wint... ...l early spring ...nths. Pupils who have studied leaves and stems can interpret the dots ...the scars if observed when the leaves are falling. In the early spring ...gs and branches should be collected and kept in water ... home and in ...ool. It is well to mark a special tree and observe it from time to time.

I. The Position of the Buds.

Where are buds found on the branches?

Introduce the terms *terminal* and *lateral buds.*

Describe a terminal bud, noting its position, shape, ...ze, color and waxy covering.

Compare a lateral bud in these respects with a ter...inal one. Draw a branch showing the various buds ... it.

II. The Scars.

How many different kinds of scars are on each branch? ...ccount for each kind.

It may require further observations for the children to find an answer to ...s.

Draw a branch showing the buds and various scars.

On the drawing mark the growth of the branch during ...e previous year.

III. The Buds Developing.

Observe the buds developing.

Describe the appearance of the bud when it is abo to open and compare it with the same kind of bud tak some weeks previously.

Draw it in its swollen state.

Observe the changes in the appearance of the varnis Discover why it is disappearing.

Observe how the brown scale-leaves are separatin Describe the scale-leaves as to number and positio Discover the purpose in the arrangement of the scal leaves in the inner and outer whorls.

Describe each of these pairs of scale-leaves. Discov why the outer scales are so short and thick and toug while those next are longer, thinner and of a delica texture, and the inner-most green and very thin.

Observe the projecting green tip and its woolly cove ing, also the cord-like ribs meeting below. Discover th use of each.

Examine the woolly-like ball and discover what really encloses. Describe the way in which (*a*) the out pair of leaves, (*b*) the inner pair of leaves, (*c*) the thir pair (if any) are folded and infer why this is best for th leaf. Observe what became of the scales, and infer wh they fell.

Teach terms *leaflet* and *midrib*.

IV. The Leaf.

Describe a leaf as to its shape, the number of part edge of the leaflets and the veins.

Draw a leaf in different positions.

V. The "Thick" Buds.

Examine the "thick" buds. Discover why so "thic or fat." Describe the tiny grape-like mass in the centr Infer what it is and why the inner green scales kee around it when it is developing.

I. The Markings in the Twig.

fter the leaves have fully opened and the scales have n off examine the twig and branch again. Pull off w leaves. Observe the semi-circular scar each forms a dot for each leaflet. Infer the reason for the e-shoe marks, also for the rings of scale-leaves.

ount the number of rings beginning at the tips of the nches. Determine how many sets of scales (otherwise s) have helped to form the branch. Infer the number ears the branch has been growing.

ontinue the observations of the tiny grape-like cluster ng May and early June.

he horse-chestnut bud illustrates in a marked way *Nature protects her children.*

THE MAPLE-TWIG, FLOWER AND FRUIT.

irect each pupil to have a maple-twig broken by self from a particular tree which he has selected for rvation.

The Markings and Their Significance.

hat markings are found on your twig?

how the bud-scale scars.

how the part which grew last year.

xplain your reason for selecting this part as that ch grew last year.

escribe the other markings.

nfer the cause of these marks

lake a cross-section of the part which grew last year.

necessary the term *cross-section* should be taught.

escribe the cross-section.

ith a pin or sharp-pointed knife examine the central t.

ompare this part with the layer next to it.

Peel off the outer part.

Give the terms *pith* or *cellular tissue*, *wood* or *fi*
tissue, and *bark*.

Draw a cross-section of the stem, showing the t
distinct parts.

Using a lens compare the cross-section of a stem
year old with that of a stem several years old.

Make longitudinal sections of parts of twigs of vari
ages; compare them and draw them.

II. The Medullary Rays.

Notice any radial markings to be seen in the long
dinal as well as in the cross-sections of the twigs.

Where are they found?

Give the term *medullary rays*.

Compare the wood in the medullary rays with
about them.

III. The Lenticels.

Observe the specks which are found in the bark
twigs.

How are they formed?

How are they arranged?

Give the term *lenticel*.

IV. The Bark.

Make a cross-section of a twig of basswood.

Compare this cross-section with that of the ma
twig.

Examine the bark of the basswood-twig to disco
its parts.

Discover if the maple-twig has the same parts i
bark.

Give the terms *liber* or *inner bark*, *green layer*
cortical layer.

Make a cross-section and a longitudinal section of the stems of the tulip and adder's tongue and as soon as possible make similar sections of the stems of Indian corn and asparagus.

Make a drawing of these sections.

Compare them with similar sections of the maple-twig.

Contrast the arrangement of the woody part in the stem of the Indian corn and in a branch of the maple.

When trees and shrubs are in full leaf discover where there is much sap in the branches.

Infer where growth is taking place.

Give the terms *exogens* and *endogens*.

Advanced pupils will be interested in observing the following:

(1) The development of the medullary rays.

(2) The cambium layer and its association with the row of delicate young cells between the wood and the bark.

(3) The bast and parenchyma cells of the inner bark.

V. The Arrangement of the Buds.

Point out the position of the various buds.

Give the terms *terminal* and *lateral* buds.

Observe the terminal bud and discover into what it is developing.

Note the way in which the new leaves are arranged along the stem.

Compare this arrangement with that of the leaves of other trees in the neighborhood, as the horse-chestnut, elm, basswood and beech.

Observe the lateral buds on the stem of last year's growth and discover what they will become.

As the new stem develops and the season advances observe the lateral, or axillary buds.

How does the new stem differ from that of last year?

Compare the structure of the new stem with that of a sunflower or flax.

VI. The Flower.

Examine the flower-cluster.

Select a single flower and describe the parts present.

Compare the parts of this flower with those of other maple-flowers of the neighborhood.

Note the date of the blossoming of the tree and compare it with the time other trees blossom.

VII. The Fruit.

Watch the development of the fruit.

Give the term *key*, or *samara.*

Draw a maple-key.

Compare the shape and size of the keys with those of other maples of the neighborhood.

Compare the fruit of the maple with that of the elm.

Infer why these fruits have wings.

Find a sprouting maple-seed.

Note the time when the seeds of different kinds of maple-trees may be found sprouting.

In what kind of soil does the maple grow to greatest perfection in your neighborhood?

VIII. The Leaf.

Where do the new twigs grow?

Of what use are twigs to trees?

Count the leaves on a single branch.

Discover how the twigs are enabled to support the leaves.

Advanced pupils should discover from the form and arrangement of the bast and xylem cells why maple-twigs are tough and strong

Try to discover how twigs are able to resist gusts of wind.

The following experiment will help to show the effect of the elasticity of the twigs.

Tie a piece of twine to a weight such that the cord will break when an attempt is made to lift the weight with a jerk. Then attach the same string to the weight by means of an elastic band and by a jerk, even more vigorously than before, raise the weight. The string remains unbroken.

THE APPLE-TWIG.

In winter or early spring direct pupils to observe the apple-tree. Note e many different shapes and sizes of the twigs, their firmness and crooked pearance as compared with those of most other trees. Collect several igs; compare their form and markings. Develop the buds on some of em by keeping their cut ends in water in a place where the water will not eze. Keep the others dry for comparison later.

1. Observe the rings on the main branch, also on the vigs. Infer the cause of these rings. Note the number times these rings occur on the branch or twig and lculate its age.

2. Compare branches of different ages.

3. Select a branch showing two years' growth. Ob-erve the difference in the markings of the two years' rowth, and discover if possible the cause of the difference.

4. Examine the terminal bud. Observe the bud unfold. ote its contents. As the twig lengthens observe the osition of the leaves. Compare new buds forming in e axils of the leaves with older buds.

5. Observe the leaf-scars from last year and the buds bove them. Discover into what these buds will de-elop.

Teach terms *lateral, axillary* and *terminal* if pupils have not had them efore.

6. Observe the buds nearest the terminal bud. Dis-over why these develop much more readily than do hose lower down. Discover also why some are dormant.

7. Discover why some of the twigs grow so much longer han others.

8. Draw two twigs (1) showing the new twig as it engthens with leaves spread out, (2) a twig of last ear's growth.

9. Observe the broken ends on some of the twigs or maller branches. Note the age of the part on which hey are found. Compare these broken ends with buds. Discover why the difference. Do any of these ends ppear as terminal? Infer the reason.

Teach the name *fruit-spurs.*

10. Observe the work of the fruit-spurs. Discover wh they cannot bear fruit each year.

11. Describe the buds sent out by those spurs n bearing fruit. Discover into what these buds develop.

12. Describe the markings left by the flowers that d not set. Compare these with the other markings on th branch.

As soon as the flower-buds appear a special and profitable study may made of these.

After the fruit has been gathered and the leaves have fallen continue t spring study.

13. Observe and compare several branches and twig Discover (1) the age of the twigs, (2) the number o apples each bore, (3) the probable fruit-spurs for nex year, (4) where the blossoms did not set, (5) the dorman buds, (6) where apples fell before they were fully deve oped, (7) where the fruit-spurs apparently changed an became strong growth, (8) places where terminal bud were injured and lateral buds developed into fruit-bud (9) accidental markings of any kind.

14. Make drawings of the different parts of the branc

THE APPLE.

The apple-tree has been observed; study "the apple" as the acco plished work of the tree—as a good work. Note that like all good wor "it is twice blessed—it blesses him that gives and him that takes." T apple is as useful to the apple-tree as it is to man. Behind all accomplish work is process and effort. Note the different processes and mark th assistance given in this case (as in nearly every case) to honest effort b influences outside of itself.

1. Each child in the class has an apple taken b himself from a tree.

2. On what kind of tree do apples grow? Describ the tree from which you plucked your apple. Examin your apple. Discover how it was fastened to the tree.

3. Do apples ever grow on any other kind of tree than apple-trees? Compare with other fruit-growin

...es. Infer from this "production after its kind" how ...dividuality and the concentration of energy, as shown ... everything in nature, is the best way to live.

...f the class has the opportunity of observing grafts the beautiful point of ...he strong helping to bear burdens other than their own, and how they ...ive under such burdens," might be brought out.

4. How long does it take the apple to grow?

5. How old are apple-trees before they begin to bear?

6. How does the tree get itself ready for fruit-growing?

Elicit from observations made heretofore:

(*a*) The work of the different parts of the tree in order that it may grow.

(*b*) The assistance given it by rain, clouds, sunshine, air, wind, soil, earthworms.

(Note the kind of help each of the above gives.)

(*c*) The help given through man's cultivation.

Note planting, pruning, grafting, ploughing about roots, and destruction of injurious insects.

7. Describe your apple, its color, shape, hollows, size. ✓

8. Describe the stem. Discover why it is so hard and ...ough. ✓

9. Through what parts of the tree was nourishment ...arried from its roots to the apple?

10. Discover what the little five-pointed brown things ...ound in the eye are · also the tiny dried thread-like ...hings. ✓

11. Draw an apple-blossom from memory. Show the ...ifferent parts enlarged.

12. What part did you find developed into the apple? ...ell how each of the other parts assisted. How the bee ...ssisted. Model the apple in clay. Draw the apple in ...ifferent positions. Draw the apple on a twig. Color it.

13. How can you tell when an apple is ripe? Of ...hat use is the skin? the fleshy part or pulp?

14. Cut your apple crosswise. Draw one half. Show ...he five-pointed core. Examine the seeds and note their ...olor. What does the color of the seed indicate?

15. Cut one of these halves lengthwise. Examine the divisions when looked at thus. Describe these seed pockets, their central position in the apple (infer why placed in the centre), their length, their width, their thin tough walls, so smooth and shiny.

16. Discover the use of these walls to the seed.

17. Why are the seeds so carefully protected by nature? Examine the seed—its two coats, its smoothness. Discover how this is a protection to the seed.

18. Observe several different kinds of apples. Compare their qualities.

Note.—

Many interesting observations might be made on the following:

(*a*) How to pick and pack apples.
(*b*) How to store them.
(*c*) The best kind of apples for shipping.
(*d*) The different uses made of apples.
(*e*) The principles of grafting and pruning.
(*f*) Cultivation of soil in orchards.

THE CODLING-MOTH.

Each child has an apple that contains or has contained a larva of an insect; most probably that of the codling-moth.

1. Cut the apple across. Cut some in different directions to discover the path of the insect. Observe the insect. Describe it. Examine your apple and discover if possible how it got into the apple. Why did it go into the apple? Some apples show that larvæ of insects have made their homes in them. Discover how they got out. Observe the brown casts. Infer how they got in at the eye or stem of the apple.

2. From what you have discovered about the larva infer how it would be likely to spend the rest of its life.

3. Observe the different means taken to destroy these insects.

4. Draw a part of an apple showing the tunnel made by the larva. Draw the larva and the moth.

There are generally two broods of codling-moths. The first brood deposits eggs in the blossom. As the apple develops it bores into the apple. In three or four weeks it is fully grown and leaves the apple—spins a cocoon—seeking shelter wherever it can. In about two weeks the moth appears. This brood generally deposits eggs in the eye of the apple.

WOOD.

Study of the structure and growth of wood with the formation of the grain.

Provide each pupil with cylinders of pine, maple, oak, etc., which have been cut from small trees with a fine saw, and with a part of the bark removed. A few of the cylinders should have knots and others should be sun-dried to show "checks."

Some should be split and the surface polished.

Each pupil should have a simple lens. There should be also a compound microscope and a set of bench tools.

I. Kind of Wood.

What is the material of which each block is composed?

From what kind of a tree has each been taken?

(Write the name of the kind of tree on the block.)

Examine and describe the different surfaces of the pine block.

Teach names *heartwood*, *sapwood*.

Compare the surfaces of the other blocks, noting resemblances and differences.

Examine the circular surfaces of the pine-block more closely.

What is there in common about both areas? Infer the way in which these rings have been formed, and the reason why the two areas are of different colors.

During what season of the year does a tree grow?

What conditions of the growing-time are the most favorable for growth? Infer then the reason why some of the rings are thicker than others.

Which of the rings has grown last? Examine the cylinder cut fresh from a young tree.

In all probability a little assistance will have to be given here. Direct attention to the mucilaginous sap between the bark and woody part. If examined under a strong microscope it will be seen as very thin wood cells.

The accurate record which the tree thus keeps of its complete life-history, of seasons of plenty with warm sunshine and pleasant showers, of periods of want, embittered it may be by biting winds and chilling frosts, may be a strong stimulus to the imagination of the child.

II. Medullary Rays.

Are there any other markings on the circular surface? Describe them. Infer why these lines are called rays.

Try to split the block in various directions using a strong knife.

Along what lines do the blocks split most easily?

Try to split the block with knots.

Examine the split surface and explain why it was difficult to split.

Cut slabs from the cylinders.

Explain why the blocks may be split in these planes.

Examine and describe the split surfaces.

What relation do the lines on the split surfaces bear to the rings of growth?

Split slabs from the other kinds of wood and compare the graining in the different forms.

On what does the nature of the graining depend?

Elicit from the pupils, by recalling observations made, the following:

The form of the grain depends on :—

(1) The thickness of the annual rings.

(2) The regularity of these rings in shape.

(3) The straightness of the stem.

(4) The presence or absence of knots.

(5) The coarseness or firmness of the wood-fibres.

Cut some of the cylinders into quarters. Make slabs from these in various planes. Compare the graining in the several cases.

Which do you consider the most handsome grains?

Cut the different woods. Which are hard to cut and to work? Which are easy to cut and to work?

Polish the surface by rubbing the slabs with fine sand-paper.

From your observations suggest uses for the different kinds of wood and discover why they are thus used.

The oak, for example, has wood that takes a high polish; the graining is beautiful; it is hard, firm and durable, hence a great deal of it is manufactured into furniture.

Encourage pupils to study and make collections of different kinds of wood for themselves.

THE POTATO.

Observations are to be made in a potato-patch when the plants are in various stages of development. Have also tubers, young and old, in the room.

I. Planting.

Observe how the ground is prepared before the potatoes are planted.

Observe how potatoes are cut for planting.

What must be on each part?

How deep in the ground are potatoes planted?

What is the proper time for planting?

Dig up plants at various stages of development and observe how the roots spread.

Distinguish the roots from the underground stems.

Determine how many tubers form on each underground stem

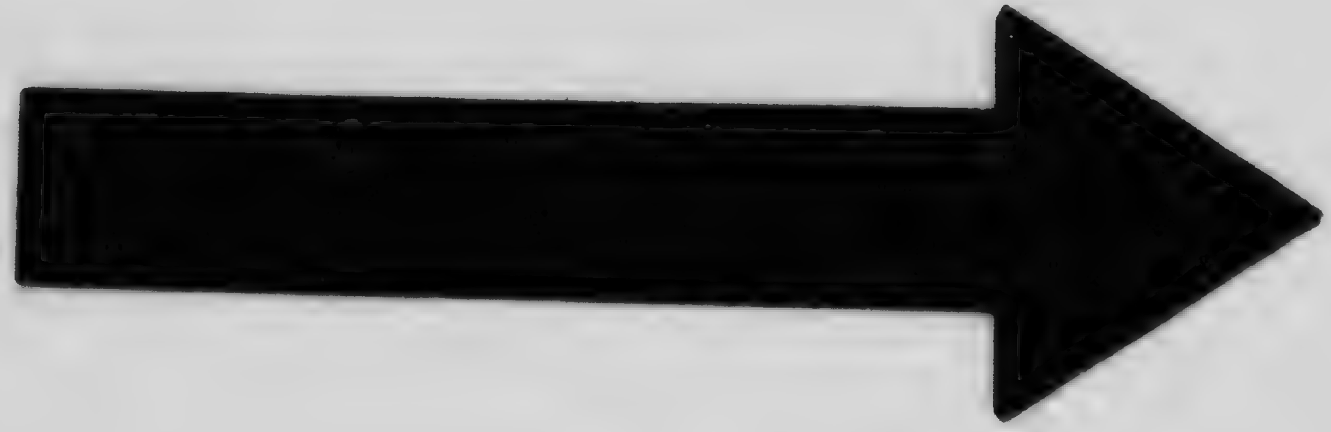
What is the use of heaping earth around the growing plant?

II. The Flower and Fruit.

Observe on what part of the plant the flower is found.

Describe the flower.

Draw it.



Observe the fruit if it can be found.

Describe and draw it.

Into what does it ripen?

Distinguish between a tuber and the fruit.

Potatoes may be grown from seeds. Into a box put some soil; sow the seeds; just cover them with earth and keep it moist.

Discover why a potato or part of one is planted rather than the seed.

Compare with the growth of onions from seeds and bulbs.

III. The Tuber.

How are the buds (eyes) arranged on the potato?

Discover on which part of the tuber the buds are most vigorous.

Compare these buds with those on stems growing above ground.

Dissolve a few crystals of iodine in an ounce or two of water and add a drop to the freshly cut surface of a potato.

Observe what takes place.

The teacher will explain that the color reaction (blue) is the test for the presence of starch.

Why is the potato a valuable food?

At home discover the best method of boiling potatoes.

Try putting them into cold water and letting them cook and putting them into boiling water to cook.

THE CAT.

Ask pupils to observe cats at home. Notice how they eat and drink; their playfulness; their gentleness; their fondness for those who care for them; their various movements, as walking, springing, and climbing; their fondness for a cosy spot; the sounds they make and on what occasions; their treatment of their young, etc. Have a cat in school at the time the lessons are given.

I. Its Food and Drink.

What kind of food and drink does the cat like?

How does it get meat off a bone?

How does it drink milk?

II. The Mouth, Teeth and Tongue.

Notice how far back its mouth is extended.

Infer the purpose of this to the cat.

Examine the teeth and infer the purpose of the four long ones near the front of the mouth.

Draw the open mouth of a cat.

Examine the tongue.

Use a lens and discover why the tongue is rough. Give the cat a bone with very little meat on it; observe it eating and infer the use of the roughness of the tongue to the cat.

Draw the tongue.

Note how the cat laps its milk.

Compare the ways in which cats and dogs eat.

III. Its Eyes and Eyesight.

Examine the eyes—note the lids and the shape of the pupil in light and in darkness.

Shut a cat up for a short time in a dark place and let the children observe the eyes on being brought into the light and for a short time afterwards.

What change has taken place in the pupil of the eye?

Infer the use of the enlarged pupil in the dark.

Draw the eye as it appears (*a*) in a strong light, (*b*) in the dark.

IV. Its Whiskers and Feeling.

Touch the whiskers of the cat and observe how sensitive they are.

Trail a piece of meat tied to a string along the floor, and observe how the cat carries its head when following it; also the position of the whiskers.

Infer the use of the whiskers to the cat.
Note 2.

V. Its Ears and Hearing.

Examine the ears.

Note their shape and position.

Discover why they are placed where they are.

Scratch with a pin near the cat.

Observe its actions.

Discover whether its hearing is acute.
Notes 3 and 4.

VI. Its Feet and Claws.

Examine the feet.

Describe them, pointing out the number of the toes on each foot, the number of claws, where these are situated, and their shape. Discover the use made of the claws, and why they can be kept so sharp.

Why is the cat enabled to walk so noiselessly? Place the cat on the side of a post or tree. Describe how it climbs.

VII. Its Legs and Joints.

Examine the legs.

Notice how the fore-legs are hinged to the body.

Observe the great flexibility of all the joints and infer the purpose.

In what position is the fore-leg when the paw is on the ground?

Draw it in this position.

Infer the effect of this position upon the movements of the cat.

Cause the cat to jump from a table or spring upon an object, and observe (*a*) the use it makes of the hind-legs, (*b*) how it alights, (*c*) the ease with which it jumps.

Trail a ball along the floor and observe the cat's position as it creeps after it.

Notice (*a*) how close the body is to the ground, (*b*) the movements of the legs as it steals forward, (*c*) the quickness with which it springs, and (*d*) the way in which it grasps the ball.

Discover if possible why cats are so attracted by moving objects.

VIII. Its Prey.

If possible observe the cat watching a mouse and hunting a bird.

Teach the term *prey*.

Discover upon what the cat preys.

Observe how it catches its prey and how it treats the prey after being caught.

Point out how the legs, the claws and the teeth of the cat are specially adapted to its habits.

IX. Its Covering.

Examine the covering of the cat.

What is the difference between the outside part and that next to the body of the cat?

Discover why the woolly part next the body takes so long to dry after being wet.

Infer why the cat dislikes water.

Notice the change in the covering during the early summer.

Infer the reason for the change.

X. Its Young.

Observe how the cat treats its kittens, (*a*) when nursing them, (*b*) when training them, (*c*) when washing them, (*d*) and when protecting them from danger as from dogs, (*e*) and when carrying them.

Infer whether the cat has courage and affection for its kittens.

Account for its carrying its kittens from one place to another.

XI. Its Language.

Observe the sounds made by the cat when contented and comfortable; imitate the sound.

Note how the cat asks questions; imitate this sound.

Observe it when angry and imitate the sound.

XII. Its Habits.

Observe a cat after eating.

Describe how it cleans itself.

Observe it when asleep.

Note how it places its paws, its tail and its head.

Discover whether it is a sound sleeper or not.

Note the places it selects for a sleep.

Infer whether the cat is fond of warmth or not.

NOTE 1.—In giving lessons on domestic animals be careful not only to cultivate a sympathetic attitude towards them but also to show the responsibility of man for their welfare because of their dependence on him.

NOTE 2.—The whiskers of the cat are exceedingly sensitive. They warn of the slightest danger. It has been thought that their length from end to end determines the size of the hole into which the cat may venture with safety.

NOTE 3.—The cat does not depend on the sense of smell so much as on the senses of sight and hearing. It smells its prey after it has been killed before eating it.

NOTE 4.—The sense of hearing is better developed than any of the other senses in the cat.

THE DOMESTIC RABBIT.

Pupils should observe rabbits at the homes of those who keep them. A pair may be kept in an enclosure in the school-yard. There should be a pile of sand in one corner in which they may burrow, and a box to provide the necessary shelter. The skeleton of a rabbit will be of great service.

I. Its Food.

Discover what kind of food the rabbit relishes. Try grasses, carrot-tops, cabbage-leaves, lettuce, carrots, the stumps of cabbage, turnips, grain, etc. At what time of the day do they feed most freely?

Discover what the rabbit likes to drink.

Describe how it drinks and compare its manner of drinking with that of the cat.

Note I.

II. Its Home.

Why are the rabbits kept in a house or cage?

Allow them freedom and observe their movements.

Where do they hide themselves?

Notice how they burrow.

Describe how they remove the earth, noting the use made of the fore-feet and of the hind ones.

III. Its Movements.

Watch the rabbit in its cage where there is little room to move about.

How does it move its legs in *walking?*

Compare this movement with that of the cat.

Let the rabbit loose in a room or yard.

Observe how it moves when not frightened.

Describe how it *hops.*

Frighten the rabbit when it is in the yard.

Notice how it *jumps.*

Describe the movement of the hind-legs when in the act of jumping.

If possible notice the marks made by its feet as it alights, and draw them.

How far does it jump?

How many ways has the rabbit of going from place to place?

Discover which is its favorite way.

Note 2.

IV. Its Structure.—(1) The Head.

(*a*) *Neck.* Describe the neck. Note whether it is long or short.

Notice the shape of the head and its size.

(*b*) *Ears.* Where are the ears on the head?

Compare with the position of the ears of a cat.

Measure the length of the ear and compare its size with that of the cat's.

Note how the rabbit uses its ears when listening.

Discover whether its hearing is acute and infer the resulting habits.

(*c*) *Eyes.* Describe the position of the eyes.

Infer the advantage to the rabbit of this position.

Observe how the rabbit turns its eyes when a noise is made behind it.

Discover whether its eyesight is keen. Compare with the cat's.

(*d*) *Nose.* Note its position.

How are the nostrils separated?

Discover why the nostrils are in such constant motion.

(*e*) *Whiskers.* Where are the whiskers placed?

Compare their position and length with those of the cat's.

(*f*) *Mouth.* Observe the lips. Note any peculiarities of the lips.

Give the term *hare-lip.*

(*g*) *Jaws.* Observe the different movements of the jaws. How many movements has the upper jaw? Describe the various movements of the lower jaw. Infer the use of each movement.

(*h*) *Teeth.* Examine the teeth of a rabbit.

Compare with the teeth of a cat or of a child.

How many long chisel-shaped teeth are there in each jaw?

What is next to these teeth?

Where are the broad flat teeth placed?

How many of these are there in each jaw?

Infer the use of each kind of teeth.

Observe the rabbit eating a carrot or cabbage-leaf and infer the purpose of the cleft upper-lip.

Examine an incisor tooth of a dead rabbit with a file and ascertain which is the harder part of the tooth, the front part or the back part.

Infer from this how gnawing tends to keep these teeth sharp.

Draw the head.

(2) Its Feet and Legs.

Note the position and size of the fore-legs; also of the hind-legs.

Compare the size and range of motion of the fore and hind-legs.

How many toes are on the fore-foot?

Describe a fore-foot.

Describe the fore-leg.

Point out the parts of a hind-leg.

Describe each part.

Infer why the rabbit can jump so well.

Describe a hind-foot.

Compare it with the fore-foot of a rabbit, as well as with the hind-foot of a cat.

Infer how the rabbit walks so noiselessly, and also so well upon soft snow.

Note the number and position of the joints in each leg.

Compare these joints with those of the cat and grasshopper.

Draw a fore-leg, also a hind one.

(3) The Body and its Covering.

What is the shape of the body?

Compare its size with that of a full-grown cat.

Notice the covering.

Describe it.

Is there any part without fur?

Observe the color.

V. Its Habits and Disposition.

Observe the rabbit when lying down. Note the position assumed.

Where and how are the legs placed?

How does it hold its ears then?

Are the eyes tightly closed when asleep?

Compare its way of sleeping with that of a cat or dog

Draw it when it is asleep.

Observe its position when sitting.

Draw it in this position.

Observe the rabbit clean itself.

Describe how it washes itself.

Compare its mode of washing with that of the cat.

Observe a number of rabbits together.

Note what they do to and for one another.

Note whether they are gentle or rough.

Give one a cabbage-leaf.

Note whether it is selfish.

From their general way of acting infer whether they are boid or timid.

Infer whether they appreciate kindness.

How do they show that they are trustful and grateful?

Observe them playing together.

Describe their actions while playing.

Infer whether the rabbit is inclined to be social or otherwise.

How does the rabbit produce the sound called "thumping"? Why does it "thump"?

NOTE I.—In its wild state the rabbit generally feeds when the dew is on the grass, or on damp leaves or juicy bark, and hence requires very little water.

NOTE 2.—In jumping the hind-legs are in advance and outside the fore-feet. The rabbit covers about one yard at a jump.

NOTE 3.—It will add interest to show pictures of rabbits in their wild state. Wood's description of "The Rabbit at Home," as given in his Natural History, may be read to the class.

NOTE 4.—The habits and disposition of rabbits can only be explained by knowing that they did not always live a domestic life; that they have many enemies, as hawks and owls, wolves and foxes, wild-cats and weasels, etc.; and that their only protection against their enemies is furnished by their color.

THE HEN.

A hen and chickens can be kept in a coop in the school-yard, or they can be brought to school in a box covered with slats. A number of heads and legs which butchers usually chop off may be procured. These should be well washed. A stuffed specimen is very useful. A hen should be set in a quiet place some time before the observation of the eggs and chicks is undertaken. When possible pupils should also observe hens at home.

I. Eating.

Discover what kind of food the hen will take.

Feed her grain, bread, bits of meat, and observe her finding food for herself or her chickens.

How does she get food out of the ground?

Infer her use in this respect to the farmer.

Examine the bill of the hen to discover how it is adapted to pick up grain.

Describe the bill and draw it.

Discover whether the hen has teeth.

In addition to food what else does the hen sometimes swallow?

There may be no answer to this question, in which case show a gizzard, open it, explain its use, and have the use of the small pebbles inferred. Aid pupils in this by suggesting that they grind a few grains of wheat between two flat stones.

Show the crop and have its use inferred.

II. Drinking.

Give the hen some water and observe how she drinks.

Why does she raise her head when she drinks?

III. The Covering.

Select feathers from different parts of the body. Observe a large quill-feather from the wing and note :—(1) the *central shaft*, (2) the *vane*, (3) the *quill*, (4) the *barbs*, (5) the *barbules*.

As these are observed the teacher will give their names and have them described and drawn.

Compare a *down*-feather with a *quill*-feather. Discover the chief difference and infer the reason for this difference.

Direct pupils to observe the feathers lying about the hennery, to discover when they are most numerous.

Did you ever see a hen picking her feathers out?

Teach the term *moulting*.

Catch a hen that is done moulting and observe the new feathers growing.

Teach the term *pin-feather*.

Compare the moulting of a hen with the change of covering of a cat or a dog.

IV. Care of the Feathers.

Direct the pupils to discover how the hen cleans her feathers.

Describe her actions when doing this.

Pour water on a hen, discover whether her feathers are waterproof and infer why water runs off the hen.

Observe the general arrangement of the feathers and infer the purposes.

V. Flight.

Observe how a hen gets on her roost.

Frighten her and observe her fly.

Describe the position of the wings in the act of flying.

Observe the arrangement of the feathers in the wings and infer their use in flying.

Illustrate by cutting pieces of paper with teeth so that they may fit together.

VI. Feet.

Examine the feet of a hen.

Describe these as to shape, position of the toes, number of toes, protection of toes.

Draw the foot.

Observe the hen walking, scratching and roosting, noting the form of the toes in each of these.

Examine the leg of a hen and discover why she does not fall off her roost when asleep.

Draw the bones of the leg and show the position of the ligament which bends the toes when the weight of the body rests on the bent leg.

VII. Hearing.

How do you know a hen can hear?

Examine the head of a hen to discover its ears.

Describe their position and appearance.

VIII. Smelling.

Discover the nose of the hen.

IX. Seeing.

Examine the eyes and discover the number of lids, and their position.

Describe and draw an eye.

X. The Language of the Hen.

Observe sounds made by the hen when she calls her chickens for food; when she is quieting them folded into her breast by her wings; when she has laid an egg; when she is disturbed on her nest; when a cat or dog is interfering with her chickens.

Have pupils imitate these various sounds, and infer the feeling of the hen at the time.

XI. The Nest.

Observe a hen's nest; notice where it is built, the material of which it is made, the use to which it is put.

XII. The Egg.

Observe the shape and size.

Draw an egg.

From noticing their position in a nest infer why eggs should be oval.

Carefully remove the shell from a part of the egg and observe the number of linings.

Note the contents and their position.

Teach the terms *albumen* and *yolk*.

Observe a small white spot on the upper side of the yolk and by examining eggs which have been set under the hen for various times note the change in this white spot as the hatching goes on. Infer what it is.

When the chick breaks out of the shell compare its covering with that of the hen.

Observe how the mother-hen feeds it and how she defends it.

XIII. The Uses.

State the uses of the hen to man (*a*) when alive, (*b*) when dead.

THE ROBIN.

The robin is one of the earliest birds to return after the long winter. Pupils should be asked to watch for its return and to note the characteristics of this interesting bird. In continuing the investigation a last year's nest in good repair and a stuffed bird will be helpful.

I. Its Return.

Observe the date of the return of the first robin in the early spring.

Register it and compare it with the time other birds arrive.

Describe the markings of this bird.

Where does the one to arrive first seclude itself until the coming of its mate?

Note the song of the robin on its return.

Imitate it.

Infer from it and its actions whether it is glad to return to its home.

In what kind of trees or bushes do they shelter themselves on their return?

Infer their reason for this.

II. Their Appearance and Structure.

How long is the robin from the end of its tail to the tip of its beak?

How tall is it as it stands erect?

Observe its head. Note the length of its bill, the position of its eyes and ears.

From the way it finds its food infer whether it has keen sight or not.

Observe its legs, the number of parts in the leg, and the number of toes.

Compare the leg and toes of a robin with those of a hen.

Sketch the claws and leg. Show how they are adapted for grasping and holding.

Which is the larger bird the male or the female?

Describe the difference in appearance of the male and female birds.

III. Its Food.

Discover what the robin eats.

Infer why gardeners at times welcome the robin, and again drive it away.

IV. Its Nest.

Note the size, shape and material of which the nest is made.

Describe the usual situation of the nest.

Observe the tree preferred by the robin in which to build its nest and note in which part of the tree the nest is placed.

Does it build in the woods or near the home of man? Note 1.

Observe whether the old nest is ever used a second time.

Observe the bird collecting material for the nest.

Note which bird does the work of building.

Describe how it uses its bill, claws and breast to fashion the nest.

Describe the lining of the nest, and tell where the bird gets it.

How long does it generally take to build a nest?

While one bird is nest-building what is the occupation of the other?

V. Its Eggs.

Observe the number, color and size of the eggs.

Draw an egg and model one in clay.

Infer the advantage of the color of the eggs.

Describe the actions of the birds when their eggs are being disturbed by boys, bluebirds, blackbirds or crows.

Imitate their cry at this time.

Which bird sits on the eggs until they are hatched?

What makes the bird so inconspicuous when on the nest?

How long does it require to hatch the eggs?

Describe the conduct of the other bird when its mate is on the nest, and when it leaves it for food, etc.

VI. Its Young.

When the young are hatched out what becomes of the egg-shells?

Describe how the young are fed; how they are kept warm and protected when it rains and how the nest is kept clean.

Describe the young bird—note the covering of the body; the size of the mouth and the appearance of the eyes.

On what are the young ones fed.

How long is it before the young attempt to leave the nest?

Describe their appearance on leaving the nest.

Describe the attempts of the old birds to teach their young ones to fly.

After the young leave the nest do they ever return to it?

How long do the parent birds continue to care for them?

How many broods of young are raised in a season?

VII. Their Migration.

Register the date when they leave for the south and compare it with the time other birds leave.

Which of the robins goes first?

NOTE I.—The robin likes to be near man. It usually builds its nest near a house. It is to this characteristic that it owes its name. When the first English settlers on this continent saw this friendly bird with a breast colored somewhat like the favorite of their far-away home they gave it the name robin, though the two birds are really quite unlike except a general resemblance in color.

THE SNAKE.

Snakes are beautiful, graceful animals. Most of the North American species are harmless; indeed, all except the rattlesnakes, massasaugas, copperheads and harlequins are so. There is no authentic report of any other venomous snake in Ontario than the rattlesnake. Garter-snakes, green-snakes, water-snakes, racers, milk-snakes and blowing-adders have no poison fangs, and living as they do largely on insects and field mice they are generally useful to the agriculturist and should be protected. That they sometimes eat the gardener's friends, the toads, is almost the only charge that can be laid against them.

Confine a garter or other harmless snake in a box having a wire-net lid. A box with such a lid and without a bottom, resting on a separate board for a bottom, is best. In such a box it is easily kept clean. The snake will appreciate a handful of fresh grass or leaves now and again.

I. Its Food and Eating.

Discover what kind of food it will take.

Try insects, earthworms, bits of meat, milk, etc.

Infer whether the snake is useful to the farmer.

Observe its method of moving its lower jaw when it is taking an earthworm.

At first the snake will be timid and will not eat when observed, but it soon becomes tame.

Tempt its appetite with a small frog.

II. Its Mouth.

Using a small stick or lead pencil discover how the snake can swallow an object of greater diameter than its own head.

III. Its Teeth and Tongue.

Observe the teeth, their form, number, position and the direction in which they point, and infer why it is difficult for an animal which the snake has seized to escape.

Observe its beautiful forked tongue and try to discover its use.

IV. Its Eyes.

Touch its eye and discover whether it has eye[illegible]

V. Its Nostrils.

Observe its nostrils and note its breathing.

VI. Its Ears.

Discover whether it can hear. Has its ears external openings?

VII. Its Skin.

Describe the covering of the snake. Count the rows of scales. Is each scale flat or ridged? Beginning at

the middle row on the back give each row a number—one, two, three, etc., and tell its color.

Compare the scales on the under side of the body with those on the upper side in respect to size, shape and color, and infer why there should be such difference.

Compare the scales on the head with those on the back. Make a drawing of the head.

VIII. Its Movements.

Use a pane of glass for the floor of the box, and observe how the snake moves itself.

IX. Its Casting its Skin.

Give it food and water and keep it in confinement until it sheds its skin. Its sluggishness and glassy eye will warn the observers of the time.

Observe how the skin comes off.

This may occupy several minutes only, but more likely several hours.

If a descriptive text-book is at hand Fifth-form pupils will be interested in counting the gasterosteges, urosteges and rows of scales and noting the characters of the cephalic plates, in order to identify the species.

Illustrate the record of your observations with drawings wherever you can.

THE FROG.

A shaded corner of the school-yard may be provided with a shallow water-tight box or a tin dish, sunk to the level of the surrounding ground, a few stones and some loose pieces of sod. This will serve as a temporary home for a few frogs while the pupils are studying their characteristics. When possible pupils should also observe frogs in the neighborhood of ponds, pools and ditches.

I. Its Food.

Discover the kind of food relished by the frog.

Try worms, grubs, flies, bread, meat, etc.

Observe how it uses its tongue.

II. Its Structure.

(*a*) THE HEAD.

(1) *The Mouth.*

Observe the form and size of the mouth.

With a small, firm stick open it and note the shape of the upper and lower jaws.

(2) *The Teeth.*

Examine the teeth.

Where are they situated?

After observing the way in which the frog swallows its food infer the use of teeth to the frog.

Compare as to size, number and position, the teeth of a frog with those of the cat, snake and fish.

(3) *The Tongue.*

Discover where the tongue is attached in the mouth. Where does the end lie?

Infer the purpose of this arrangement of the tongue.

Infer the use of the sticky fluid covering the tongue.

Draw the open mouth of the frog, showing the tongue and the teeth.

If you have seen the frog catching a slug draw the tongue in the act.

(4) *The Eyes.*

Note their position. Gently touch the eye with the point of a pencil and note the result. How many eyelids are there? Where are they when not in use? Observe the shape of the pupil. Draw an eye.

(5) *The Nostrils.*

Discover them and note their number and position.

(6) *The Ears.*

Discover whether the frog can hear.

Where is the ear-drum placed?

(*b*) THE LEGS.

Examine a fore-leg.

Of how many parts is it composed?

How many toes are there?

Draw a fore-leg.

Examine a hind-leg; note the parts of which it is composed, the number of toes and how they are connected.

Contrast a fore and a hind-leg.

Draw a hind-leg.

(*c*) THE SKIN.

Observe the general shape and appearance of the frog.

Where is the neck of the frog?

Note the color of the upper surface of the head and back.

Compare the color of the upper and under surfaces of the body.

If possible discover whether the frog can change the color of its body.

Infer the purpose of the color and color-markings.

Discover whether the skin is sensitive or not.

III. Its Movements.

Notice how the frog sits when at rest.

Draw it in this position.

When on land how does it move from place to place?

What particular feature of its structure fits it for this kind of movement?

Observe a frog swimming.

Draw one in the act of swimming, when the hind-legs are fully extended.

Note the peculiarities of structure that fit the frog for swimming.

IV. Its Breathing.

While the frog is at rest observe its throat, nostrils and the sides of its body.

What process is indicated by these actions?

V. Its Home.

Discover where frogs are commonly found.

Observe it and note whether it spends the greater part of its time on land or in the water.

Try to find out what becomes of frogs on the approach of cold weather.

What do they eat at this time?

Give the term *hibernate.*

VI. Its Language.

Imitate the sounds made by the frog.

During which time of the year is the sound most frequently heard?

VII. Its Spawn.

Procure a mass of frogs' eggs from a pond or ditch, and keep them in wide dishes of water to hatch. Change the water every two or three days, taking fresh water from a pond or ditch, not from a well.

Describe the mass of eggs

Examine a single egg. Describe it. Draw it.

What are the first signs of life observed in the eggs?

VIII. The Tadpole.

Describe the creature that comes out of an egg as it breaks.

How does it swim?

Examine closely for gills. Describe any appendages you may find it has.

Examine its mouth to discover whether it has teeth or a tongue.

Discover what the tadpole eats. Try insects, worms, bread, small water-plants, etc.

Describe the changes which gradually take place in the tadpole as it develops.

Which disappears first the tail or the gills?

Which develop first the fore or the hind-legs?

Introduce the term *metamorphosis.*

Draw tadpoles illustrating various stages in their development.

NOTE 1.—Place one of the tadpoles on a piece of glass with a little water, and examine the gills with a microscope. The flow of the blood can be readily seen.

NOTE 2.—Procure a thin piece of board as a shingle, cut a V-shaped notch in one end, wrap a frog in a wet cloth, with a leg projecting, and tie it to the board with a part of the web stretched not too tightly over the V-shaped notch. Examine with an objective of low power. Arteries, veins and capillaries will be plainly visible. With a higher power the corpuscles can also be distinctly seen.

THE FISH.

In addition to observing fish in a neighboring stream a number of minnows or other small fish should be placed in an aquarium. A tub partly filled with water will answer very well. The water should be changed every day.

I. Its General Appearance.

Notice the shape of the fish.

Point out the *head*, the *body*, the *tail.*

Draw a fish.

II. The Head.

(1) *The Mouth.*

Examine the mouth; note its shape when closed and when open.

Discover whether the fish has teeth; where they are situated; how they are pointed, and infer their use to the fish.

Discover the tongue; feel its surface with the tip of the finger. Can it be protruded?

(2) *The Eyes.*

Note the shape and position of the eyes.

Discover whether there are eyelids or not.

What provision is made for protecting the eye-ball?

Discover whether the eye-ball can be turned in various directions.

Observe the pupil.

Draw an eye.

(3) *The Nostrils.*

Discover the nostrils, note their number, exact location and arrangement.

(4) *The Ears.*

Discover whether a fish can hear.

(5) *The Gill-Covers.*

Observe the flaps along the sides of the head.

Note which edges are free and where they are attached.

Examine the large openings along the sides of the head. Note their extent.

(6) *The Gills.*

Raise a gill-cover and observe the red structure beneath it.

Of what does a gill consist?

How many gills are there? How many gill-clefts?

Observe the movement of the lower jaw and gills.

Discover the connection between the rhythmical arching of the gills and the opening of the mouth.

Discuss the reason for this.

Remove a fish from the water for a short time and observe how this affects the fish.

III. The Body.

Note the outline of the body as seen from above, from the sides, and from below.

Make sketches showing these outlines; mark the lateral line.

Observe the covering; note the arrangement of the scales; their size; their thickness; their shape and color.

Give the term *scale.*

Sketch a scale.

Infer the advantage to the fish of having the scales arranged as they are.

IV. The Appendages.

Point out the appendages to the body.

Point out those nearest the head. How many are there? Compare their position on opposite sides of the body.

Give the term *pectoral* fins.

Sketch a pectoral fin.

Observe another pair of fins situated farther back and more nearly on the under surface.

Give the term *ventral*, or *pelvic* fins.

Sketch a ventral fin.

Observe the fins extending along the middle of the back.

Stretch them out and observe the number of bony structures forming the frame-work.

Give the term *dorsal* fin.

Examine the fin forming the tail of the fish.

Spread it out and note its appearance.

Give the term *caudal* fin.

Draw the caudal fin.

Compare the upper and lower halves of this fin.

Are they symmetrical or not?

Examine the fin on the middle line of the lower surface of the body, just in front on the caudal fin.

Give the term *anal* fin.

Point out the fins which grow in the middle line of the body.

In what direction do they extend?

Do they occur singly or in pairs?

Point out the fins which grow in pairs.

How many such pairs are there?

Name parts of the frog, the hen, and man which are homologous to the pectoral fins.

To what part of the frog are the pelvic fins homologous? of the hen? of man?

Draw a fish and mark the name of each fin shown.

V. Its Food.

Offer different kinds of food to the fish, such as insects, worms, crumbs, etc., and discover which kind it likes best.

Describe how it eats.

Fish are generally timid and not very intelligent. However, in time they learn to know those who feed them.

VI. Its Movements.

Observe the easy, noiseless, graceful movements of the fish, and discover how it makes them.

Point out how the shape of the head and body facilitate rapid motion through the water.

NOTE I.—If a test-tube of boiled water, well shaken or beaten with an egg-beater, be placed beside a similar test-tube of unshaken boiled water air bubbles will be noticed on the former after a time. This will show that water absorbs air. It is this air which supports respiration in the water.

THE EARTHWORM.

Bore holes in the three sides of a good-sized wooden-box to admit air. Almost fill the box with rich moist earth mixed with partially-decayed leaves and stems. Plant in this earth some growing fibrous roots. Collect some earthworms; leave them on top of the earth. Put the box in a somewhat shady part of the school-yard. At times moisten the top by way of encouraging worms to come to the surface.

By this means some satisfactory observations on earthworms can be conveniently made. Earthworms, however, are seen to best advantage in their native home, after a warm rain in early morning or on a dull day. Do not fail to see them when opportunities for such observations occur.

I. The General Appearance and Structure.

Take a fresh earthworm and examine and compare the two ends of the body.

Which do you think is the forward end and which the hinder end?

How do the two ends differ?

Place a worm upon paper and observe its movements.

Turn it over and note what happens.

Which is the lower surface of the worm?

Which is the upper surface of the animal?

In what respects do they differ?

Of what is the body of the earthworm composed?

Are these segments everywhere exactly alike?

Note a thick band a little back of the anterior end of the body.

Describe this band.

Over how many segments does it extend?

How many segments are in front of the band?

Examine the surface of the body by laying the worm over the tip of the forefinger and dragging it backward and forward.

Seize a worm near the posterior end with a pair of forceps and draw it backward. Is there resistance? With a lens discover small bristle-like structures in the body-wall.

Where are they situated and how are they arranged?

In what direction do they point?

Give the term *seta*.

Why is it difficult for a robin to drag an earthworm from the ground?

Draw an earthworm.

II. Its Movements.

Dip a worm into water to moisten its body and then place it on a sheet of paper. Watch its motions.

How does it crawl?

What use are the setæ in crawling?

Does it move with the same end always foremost?

Gently touch one end with a pencil and note the result.

Touch the other end and infer which is the more sensitive.

Discover how it is enabled to climb a smooth vertical surface.

III. Its Food.

Discover the kind of food on which the worm lives.

Try raw meat, cooked meat, onions, cabbage, leaves of plants. Bury portions of these in the box and examine sometime later. Infer a use of the worm to man.

IV. Its Home.

Put two or three worms in a glass of damp earth and observe how they bore their way through the ground.

Observe and examine worm-casts.

Note how they are heaped, the shape of each and its general appearance.

Discover where these casts came from and how the worm brought them to the surface.

Keep a worm out of the ground for a time and then compare it with one just taken out.

What difference is noticeable.

Infer the reason for this.

With a trowel remove layer after layer of earth and expose several worm-holes, being careful to examine the holes as they descend.

Note what is found in the holes.

Infer the use of these to the worm and to man.

Describe the home of the worm.

Note its rows of halls and how the walls are prevented from falling in.

Draw a plan of the home of the worm.

Place a few worms in a small water-tight box partly filled with earth, and after they have burrowed a home for themselves pour a little water into it.

Observe the actions of the worms.

Infer why there are so many worms to be seen just after a rain-storm.

Observe whether worms live alone or are social.

Collect the worm-casts for a few days from the same square yard of earth. Weigh them and then estimate how much would be brought to the surface during one day on an acre.

Do worms bring up as much earth during the day-time as they do at night?

Infer the effect of their work upon the soil.

What service is this to the gardener and farmer?

Examine the roots of the plants in the box and note whether worms are injurious to them by eating their roots.

In which kind of soil are worms found most abundantly?

If possible discover what becomes of worms in very dry weather; also in winter.

V. Its Senses.

Touch a worm gently and decide whether it has feeling or not.

Present substances of various odors and decide whether the worm can smell.

Place the worm in a strong light and then darken the room and decide whether the worm can distinguish between light and darkness.

Experiment so as to decide whether it can see objects or not.

VI. The Young Worm.

Where are the eggs deposited?

Describe the bags which contain them.

SOIL.

1. After clearing off the grass, if any, make a nearly square hole, like a fence-post hole, about two feet deep. Pare one or more sides with a sharp spade, so as to show a clean perpendicular surface. Make exact records of the color and depth of the soil and the color of the subsoil.

Teach the terms *soil* and *subsoil.*

2. Repeat this operation in different places, *e.g.*, in the school-yard near the school-house, in a corner of the school-yard, on the roadside, in a cultivated field near the school-grounds, in the woods or other situation where the soil has never been cultivated.

3. Compare variations, if any, in color and depth of soil and color of subsoil in the different excavations made.

Account so far as possible for each variation noted.

4. Of what is the surface layer in woods composed?

Teach the terms *organic*, *inorganic* and *humus.*

5. (*a*) At a selected excavation carefully take off about a peck of the soil, cutting from the surface straight down to the subsoil.
   (*b*) By hand or with a trowel break up and thoroughly stir and mix the soil on a board to obtain a true sample.
   (*c*) Weigh out a pound and spread it out thin on a board or sheet of paper. Put it in a drying-place for twelve hours or longer, occasionally stirring it to "air-dry" it.
6. (*a*) Weigh the dried soil.
   (*b*) Compare with the weight before drying.
   (*c*) Observe any change in color.
   (*d*) State your conclusions.
7. (*a*) Place the air-dried soil on a flat shovel or spread it in a pan and put on a stove, or in a hot oven for three or four hours to "kiln-dry" it.
   (*b*) Weigh again and compare as before.

8. Return the kiln-dried soil to the shovel and put it on the fire—not on the stove. When it has burned and smouldered until it ceases to smoke remove, cool, and weigh it. From this determine the quantity and proportion of inorganic matter in the soil.

9. Determine the properties and proportion of the organic matter in the soil as outlined in the lesson on "Clay and Sand."

10. (*a*) From the soil as mixed in No. 5 take enough to fill one-third of a tall wide-mouthed glass vessel. Fill the vessel nearly full with water. Stir thoroughly and shake. Set the vessel aside to settle.
    (*b*) Observe the material floating on the water and the layers forming the sediment.
    (*c*) Investigate the nature of the "scum."
    (*d*) Syphon off the water. Obtain samples from the upper, middle and lowest layers of the sediment. Dry each and examine to find differences in color and texture.

11. Infer the effects of heavy rains upon soils. Infer differences between hill-side soils and adjacent-valley soils.

12. (*a*) Take a sample from the lower layers and while stirring it allow water to run over it until the water runs off clear.
    (*b*) Describe the earth remaining.
    (*c*) What constituents have you found in the soil you have examined?

CLAY AND SAND.

1. Moisten some sand and clay. Have pupils form two sets of objects as balls, cubes, and cups, one from the sand and the other from the clay. Place these in the sun or near the stove and observe the effect of drying.

Which substance retains its form?

Which is the more adhesive sand or clay?

2. Fill two filters, one with sand, the other with clay, hollowed so as to form a cup. Gently introduce water into each.

Through which substance does water pass most readily?

Direct pupils to notice whether every part of the ground dries equally fast after rain.

Examine the soil where the ground dries most readily. Describe the soil here.

Examine the soil where the ground dries slowly.

Describe this soil.

3. Have several flower-pots of the same size and shape. Dry several kinds of soil as gravel, sand, clay and garden loam. Place an equal weight of each soil in the pots. Suspend one from a common spring balance and notice the weight registered. Now, slowly pour water upon the soil until it is thoroughly saturated and cover the mouth of the pot with a piece of oiled cloth or oiled paper. Allow the water to drain until no more will flow away. Compare the weight of each pot before soaking with that after all the water has drained away.

Which soil has increased the most in weight?

Which has increased the least?

To what is the increase of weight due?

Proceed to the application in agriculture.

4. Again, take four ordinary lamp chimneys and tie a piece of cotton cloth over the bottom of each. Place equal weights of well-dried soil in each, as in the last experiment. Set the four chimneys at the same time in a vessel having about an inch of water in it.

Describe what happens.

In which vessel does the water rise most rapidly?

After a few minutes weigh each chimney.

Which has increased most in weight?

Which has increased the least?

Compare these increases in weight with those in the last experiment.

What kind of soil would be best for plants in dry weather? In wet weather?

Why is it easier to walk or drive on a sandy road after rain than before it?

Why does moist clay adhere to one's boots?

Why is a clay soil called "heavy" and a sandy one "light"?

5. Put an equal quantity of sand and of clay in similar dishes and place on a stove.

Observe which heats more rapidly.

Remove from the stove and observe which retains its heat longer.

Infer with reasons the soils that can be earliest tilled in the spring, and in which soils seeds will germinate most quickly.

PLANTAIN—A WEED.

Collect a number of plantain-seeds and sow them in a box. Observe the rapid growth of the young plants. Observations should also be made in waste-places and in the lawns of the neighborhood.

I. The Roots.

Dig up a number of the plants both from the box and lawns or waste-places.

Describe the roots and infer why these plants are vigorous growers.

Infer the effect of this vigorous growth upon the richness of the soil.

II. The Leaves.

Describe a leaf.

Where do they grow upon the plant?

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What is their effect upon the grass and other plants overshadowed by them?

Give two reasons why plantain is not a desirable plant to have growing in a lawn or garden.

Teach the term *weed.*

III. The Flower and Fruit.

Observe and describe a flowering-stem.

Teach the term *spike.*

How many spikes may a plant produce?

Find the number of flowers on a spike and hence estimate the number on the plant.

How many seeds are in one seed-box?

Estimate the number of seeds produced by a vigorous plant.

Investigate the causes which may prevent many of the seeds from becoming plants.

Use the lens to observe the seed and make enlarged drawings of the seed and seed-pod.

Advanced classes may distinguish the different species of plantain by the form of the seed-pod, the form of the seed, and the number of seeds in a pod.

IV. Its Extermination.

To prevent the growth of young plants what precautions must be observed regarding old plants?

If young plants are prevented from growing why will not the lawn become cleared of plantain?

Teach the term *perennial.*

What must be done with the old plants so as to exterminate this weed?

How are perennial weeds exterminated?

V. Its Uses.

Discover, if possible, the uses of plantain.

THE SUN.

Procure a strip of board two inches wide and two feet long, and to one end nail a strip of the same width and six inches long at right-angles to the board. It is desirable that each pupil make or obtain one of these "shadow-boards" for himself. At noon each clear day have the length of the shadow cast by the upright piece marked on the long strip by placing this *horizontally on a north and south line.* Write the date on the 21st of each month along the line marking the length of the shadow at that time.

What causes a change in the length of the shadow?

During which months does the shadow grow longer?

During which months does the shadow grow shorter?

When is the shadow longest?

When is the shadow shortest?

When does the shadow reach about half-way between its longest and shortest positions?

How often in the year is the shadow a mean length between its longest and shortest lengths?

At the time when the shadow is a mean length compare the length of the day with that of the night.

These observations are continued for a year before pupils are required to make generalizations from them.

Give the terms *vernal* and *autumnal equinox* at the appropriate times.

In what direction from the school-building does the sun rise above the horizon at an equinox?

In what direction does it then set?

When the days and nights are of equal length observe two points on the horizon where the sun appears to rise and to set, and fix each by some landmark, as a tree or house. This should be done by each child at his own home. The teacher may make these observations at the school-house.

Imagine the points marked by these landmarks joined by a line.

In what direction does this line run?

When the shadow is shortest compare the length of the day and night.

Where does the sun rise and where does it set when the shadow is shortest?

Observe these two points on the horizon and fix each by some landmark.

When the shadow is shortest in how many days does it begin to grow longer?

Give the term *summer solstice.*

When the shadow is longest compare the length of the day and night.

Where does the sun rise and where does it set when the shadow is longest?

Observe these two points on the horizon and fix them by some landmark.

When the shadow is longest in how many days does it begin to grow shorter?

Give the term *winter solstice.*

As the shadow is shortening observe the time at which the sun rises or sets for a number of successive days.

Many schools are so situated that these variations in the shadow points at noon can be marked by driving tacks in the floor and keeping a date-plan of the talks in a note-book.

Have each pupil make a quadrant of a circle a foot in radius, and mark the number of degrees on the circumference from 0 to 90. Place the centre of the circle at the point reached by the shadow on the "shadow-board" and the circumference towards the upright part with the point marked 0 on the upper edge of the horizontal board and find the number of degrees the sun is above the horizon.

On what day is the sun highest in the heavens at noon?

On what day is the sun lowest in the heavens at noon?

Teach the term *meridian altitude.*

What is the sun's meridian altitude on June 21st? on May 21st? on Jan. 21st? etc.

What do we get from the sun?

In an east and west ravine on which slope are the earliest flowers of the spring to be found? Give the reason for your decision.

In a north and south ravine on which slope are the earliest flowers of the spring to be found?

Explain the reason for your decision.

Give two reasons why the weather grows warmer from March till June and colder from August till December.

THE MOON.

In lessons on the moon some facts will have to be told; for example, that the moon reflects light from the sun, that it is a sphere and that it revolves around the earth, and that it revolves on its own axis once in each lunation. Reflection may be illustrated by the use of a mirror; an orange stripped of a hemisphere of its peeling and revolved on a knitting-needle serves admirably in illustrating the motion of the moon and of the circle of its illumination by the sun. But these objective illustrations will succeed not precede observations of the moon itself. A strip of paper long enough to pass round the black globe or round any ball used to represent the celestial concave—the sky—will suggest how the path of the moon may be mapped out.

Draw two parallel lines about an inch apart across the full width of the open exercise-book. Mark the band off with faintly-ruled vertical lines into 28 equal spaces. Write "west" at the right-hand end of the band and "east" at the left.

The preferable time to begin observation is on the first evening the new moon is visible, usually the third or fourth day of its age.

The moon will be visible this evening in the west, shortly after sunset. Go out and observe it. Note the shape, relative width and length of the visible part and the direction in which the horns—or cusps—point. Note two or three bright stars in the neighborhood of the moon. Go into the house and make a careful drawing of what you observed—the curve and width of the crescent and the relative position of the stars. Verify your drawing by observing and comparing again and again if need be. After submitting your drawing to the teacher's inspection copy it in the right-hand space of the band in your exercise-book, and over it place the date and hour at which the observations were made.

Repeat the observations every clear evening so long as you can see the moon, and similarly enter each in the band. Leave the space blank or in it write the cause on each date when you did not make any observation.

In some of the waning days of the moon it will be visible after the children get up in the morning. Observations may be made, drawn and entered with date and hour.

The exercise should be repeated with the next moon, and, if the children are young, with yet another before they are asked such questions as:

Which way is the moon moving?

How many days does it take to go round the earth?

It is 11 a.m.; point to where the moon is now.

Point to where the moon will be seen next Saturday evening at 9 o'clock.

Make a drawing of the part of the moon that will be visible next Monday evening.

On what day will exactly the west half of the hemisphere of the moon towards the earth be visible, and at what time of that day will it be most nearly over our heads?

Many questions, of which these six are types, should be given.

Teach the names of the phases and illustrate them with the half-peeled orange.

Advanced classes may be taught to map the relative positions of the sun, moon and brightest fixed stars. They may also be led to observe how closely its path follows the ecliptic, the variations in the daily difference of its time of rising and the constant concavity of its orbit toward the sun.

TEMPERATURE.

Procure the following:—

1. Four beakers (tumblers) of water at temperatures of approximately 60° C., 30° C., 10° C. and 0° C. respectively.

2. A small quantity of water, say 60 grams (one-fourth of a tea-cup), at boiling point. A much larger quantity, 600 grams (3 tea-cupfuls), at 40° C. and a piece of ice.

3. A thermometer.

4. A Bunsen burner or a spirit lamp or a hot stove.

I. Meaning of term "Temperature" and distinction from quantity of heat.

Place the four beakers with contents named in No. 1. before the class and require the pupils to thrust their fingers into the first beaker.

Describe the condition of the water.

Thrust the fingers into the fourth beaker.

Describe the condition of the water.

State the difference (in condition) between the two quantities of water.

Now test similarly the second and third beakers of water.

Which water has the greater degree of heat, that in the second beaker or that in the third?

State the general results of your observations with reference to the degrees of heat of the water in different beakers.

The teacher may now give the term *temperature* and explain that the term means the degree of heat possessed by a substance.

Require the pupils to touch the ice.

What is the nature of its temperature?

Compare with the temperature of the Bunsen flame or hot stove.

The teacher will here introduce and explain the terms *low temperature* and *high temperature.*

Give practice in the use of these terms by having the pupils touch or feel bodies of different temperatures, as air from the register, air through the open window, the door-knob, a slate, the blackboard, etc.

Use the beakers described in No. 2.

Which water is at the higher temperature?

Place equal pieces of ice in the two beakers.

Compare what takes place in the one with what takes place in the other.

What causes the ice to melt?

Which quantity of water produced most melting?

Which, therefore, possessed the greater quantity of heat?

Does temperature mean the same as quantity of heat?

Place a piece of ice similar to above in a beaker containing twice the quantity of water at 40°C. used in last experiment. Compare the result with that observed with water of similar temperature used above.

Upon what does the quantity of heat of a body depend?

Explain the difference between the temperature of a body and its quantity of heat.

II. The sense of touch cannot be relied upon to give us accurate information with regard to temperature.

Prepare three beakers of water, A, B and C. Make A as hot as you can bear to hold your fingers in; make B of the temperature of your hand, so that it will feel neither hot nor cold, and make C very cold by putting ice into it.

Place a finger of one hand in A and a finger of the other hand in C. Continue to hold them there for a minute, then withdraw and thrust them into B. How does the water in B now feel to the finger taken from A? to that taken from C?

Compare the temperatures of the finger immediately before and immediately after being placed in A.

Compare similarly the temperatures of the finger placed in C.

Compare the temperature of the fingers immediately before being placed in B.

What caused the difference in the sensations in the two fingers when placed in B?

Is the water in B hot or cold?

Other observations should be made, as :—

Determine, by touch, the comparative temperatures of different articles subjected to the same temperatures for some time, *e. g.*, the iron head of a hammer and its wooden handle; the slate and its frame; an iron inkstand and a lead pencil beside it; a piece of oilcloth on the floor and a piece of carpet—each of the above pairs of articles when lying in the heat of the sun in summer.

Is touch an accurate test of the temperature of a body?

NOTE.—After a lesson on conduction of heat has been taken the causes of these apparent differences in temperature of bodies of really the same temperature may profitably be examined.

III. The thermometer is used in the accurate determination of temperature.

Since the thermometer with Fahrenheit markings is more generally used for domestic purposes it is more appropriate for use in these experiments. In a lesson on the thermometer the centigrade may be introduced and its markings compared with those of the Fahrenheit.

Require the pupils to thrust the thermometer into cold water.

How does the column of mercury act?

Now thrust it into hot water.

How does the mercury act?

Hold the bulb against a piece of ice.

Compare the observation with that in the first case.

Hold the bulb near a flame.

Compare the observation with that in the second experiment.

State how the mercury column acts under the influence of high and low temperatures.

Place the thermometer in contact with substances of different temperatures.

Note the height of the column in each case.

From your observations state the relation between the change in the mercury column and the temperature.

Require the pupils to find the temperature of different objects, as—different beakers of water, ice, atmosphere of room, the hand, etc.

Exercises for further observation :

1. At what temperature water freezes.
2. At what temperature water boils.
3. At what temperature the room is kept.
4. The temperature of the body.
5. How temperature is affected by evaporation.
6. How temperature is affected by sudden meltings—mixture of snow and salt.

NOTE.—It is advisable that a simple chart be kept in school on which the pupils will daily register the temperature of the outer atmosphere.

EVAPORATION.

Require pupils to place a small quantity of water in a saucer and leave it exposed to the heat of the sun or of the room, and to observe what takes place.

What has become of the water ?

Where is it now ?

What caused it to disappear ?

Observe the wooden roofs of buildings when the sun shines strongly on them after a shower.

What do you notice ?

The teacher will give the word *vapor*, and state that the process by which the liquid is slowly formed into vapor is called *evaporation*.

Where else have you noticed evaporation taking place?

Why are wet clothes hung on a line ?

What becomes of the water ?

Why are wet clothes sometimes placed near the stove?

How does increase in temperature affect rate of evaporation ?

When does the dew on the grass disappear ? Why then ?

Since the water in the saucer disappeared into the atmosphere what necessarily becomes of part of the water of our rivers, lakes, swamps, and seas?

Observe patches of snow in the fields during cold yet stormless winter weather.

How do the patches now compare in size with the same when first observed?

What caused the difference?

Where does all the vapor from these sources go?

Place over a flame a test-tube half filled with water and fitted with a cork, through which is inserted a piece of glass-tubing, its lower end being above the surface of the water.

What takes place almost immediately after the application of the heat?

What caused these to rise?

While boiling is taking place require pupils to describe the condition of the water.

How do the bubbles now seen compare in size and action with the bubbles first observed?

Observe the bubbles bursting and determine what they contain.

What do you observe issuing from the glass-tubing?

Observe carefully where it is first visible.

Do you see the vapor at the mouth of the tubing?

Do you see it in the test-tube?

How far is the point where you first see it from the end of the tube?

What must be above the water in test-tube and issuing from the end of the tubing?

What is the nature of its temperature?

How does it compare in temperature with the vapor rising from a wet roof, or from an exposed saucer containing water?

Teacher will explain that this invisible, highly-heated vapor is called *steam*, and that this violent process by which the steam is produced is called *boiling*.

CONDENSATION.

Hold a slate close to the mouth of the tube while the water is boiling.

What do you observe on the slate?

Where does it come from?

Compare the temperature of the slate with that of the steam.

How is the temperature of the vapor affected by contact with the slate?

What change was effected in the steam by its contact with the slate?

Compare the temperature of the steam issuing from the tube with that of the air of the room.

What effect upon the temperature of the vapor has its contact with the air?

What was the visible effect of this lowering of the temperature of the vapor?

Place a pitcher or tumbler of cold water in a warm room.

What do you notice on the outside of the vessel?

Where has it come from?

In what form did it exist in the air?

Compare the temperature of the glass with that of the atmosphere and its vapor.

What effect on the vapor of the atmosphere had its contact with the cold vessel?

How is the condition of invisible vapor affected by its contact with a body of much lower temperature?

This change in its condition is called *condensation*.

Under what circumstances is invisible vapor condensed?

Breathe against a cold slate.

Explain the effect produced on the surface of the slate.

Why is the breath visible on a cold morning? Why not on a warm morning?

Explain why windows in cold weather are clouded with moisture.

Is it found on the inside or on the outside? Why?

Further Observations.

In experiment under "Boiling" place the flame of the lamp close under where the vapor first becomes visible.

What effect is produced?

What caused this effect?

How far from the tube can you see the vapor?

What becomes of it after this point?

FOG, MIST AND CLOUDS.

What becomes of all the vapor constantly forming on the earth?

Does it all remain invisible?

Require pupils to make observations in the morning and evening along the river bank; in a marshy place; in a low valley, and report.

Why was the vapor seen in the places you were directed to observe rather than at other places?

Why was it seen at those particular times of the day?

What was the condition of the atmosphere?

When and why did it disappear?

When vapor is condensed and floats very close to the surface of the earth it is called fog or mist.

Have you seen such fleecy forms of vapor at any other times or places?

The child will certainly refer to clouds.

When the condensed vapor is visible in great masses high up in the atmosphere such masses are called *clouds.*

Under what conditions is the invisible vapor of the air condensed?

Infer the origin of clouds in the upper air.

Observe the quietness, rapidity, grace and direction in which they move.

What is the cause of their movement?

Observe the different kinds of clouds.

Feather-clouds (cirrus). When clouds are very far from us they are very light and feathery. They may be white or bluish.

Rain-clouds (nimbus). When low and heavy, sometimes covering the whole sky like a grey veil.

Wool-pack clouds (cumulus). Resembling great packs of wool, or the appearance of hills piled the one upon the other.

Layer-clouds (stratus). Seen most frequently in the morning, in layers one above the other, or in layers side by side.

Observe the beauty of the different kinds of clouds.

Discover their uses:—

1. In protecting the earth from the burning rays of the sun.
2. In helping the earth retain its heat at other times.
3. In producing rain and snow.

RAIN.

Frequently during spring and fall and occasionally during summer the fog is such that the pupils can easily see the small water-particles of which it is composed. On such occasions they should be encouraged to make close observations of the phenomenon.

Of what is fog composed?

Of what are clouds formed?

Supposing many of these little water-particles which you observed in the mist were brought into contact with each other, what would be formed?

What would become of such drops when formed in the upper air?

Did you ever see them fall?

What do we call them?

Give the term *rain* if necessary.

Describe the general appearance of the sky when it rains.

Discover why it has this appearance.

Observe and describe the different ways in which rain falls and note the different sounds it makes.

NOTE.—Opportunities must be seized when such can be observed. Thus it falls straight down, slanting, slowly, quickly, steadily for several days, for a few minutes. The sounds may be noted thus—dripping, pattering, roaring, gushing.

How does nature use rain to serve her purposes?

HAIL.

This lesson is well taken after a hail-storm has occurred. It may however follow the lesson on rain.

Suppose a hail-storm has very recently been observed.

What was the condition of the atmosphere with reference to clouds (their nature), wind, temperature?

Was there any lightning?

What was the nature of that which fell from the cloud?

What would you infer from this as to the temperature of the upper air?

Give term *hail* if necessary.

How large were the hail-stones?

When opportunity offers cut through the centre of a large one and with aid of a magnifying glass infer from its concentric layers the nature and cause of its formation.

DEW.

Observe the grass on successive mornings, (1) near water, (2) away from water.

Discover the cause of the dampness on some mornings.

Is it present during the day?

When does it disappear?

Why does it disappear?

When was it formed?

How was it formed?

Such moisture as this is called *dew.*

Is dew formed in greater abundance on a clear night or on a cloudy night? On a calm or on a windy night?

Which has the greater amount of dew, the grass or the board walk? the painted boards or the unpainted? the lawn or the gravel walk? Why?

During what time of year do we observe dew?

Under what conditions is it formed?

Examine thick, long grass at noon or during the early afternoon.

Do you observe any moisture on it? Can this be dew?

Give your reasons for answering thus.

Supposing the temperature were very low, below the freezing point of water, what would become of the dew as it formed?

When the water-vapor at surface of the earth freezes as it condenses it is called *hoar-frost.*

Where have you seen hoar-frost?

Of what color is it?

When did you see it?

Under what conditions is it formed?

THE LEVER AND FULCRUM.

I. Apparatus:—

(*a*) A stout pry, with a triangular block to serve as a fulcrum.

(*b*) A flat ruler twelve inches long.

(*c*) A number of equal weights.

Ask several pupils to raise the teacher's desk, or a cupboard, or any other heavy object.

Next require them to raise it by using the pry.

What difference was observed?

What do we call this apparatus?

The teacher may find it necessary to give the names *lever* and *fulcrum*.

II. To Discover the Principle of the Lever.

Place one of the weights on each end of the ruler and balance it on the fulcrum.

What distance is each weight from the fulcrum?

Place two weights side by side on one end of the ruler, and one weight on the other end, and balance the weights.

Does the ruler balance at its centre now?

To which weight is the fulcrum nearer?

How far is the fulcrum from the greater weight? how far from the less weight?

Compare these distances.

Compare the weights.

Combine in one statement the relation between the weights and the relation between their distances from the fulcrum.

An answer expressing the idea in some such form as the following may be obtained:—

"One weight is twice as great as the other, but it is only half as far from the fulcrum as the lighter weight."

If one weight is three times as heavy as the other find how their respective distances from the fulcrum compare.

After performing a number of experiments similar to the above teach the phrase *inversely proportional* in this connection, and have the pupils give verbal expression to the general idea.

III. Applications of the Lever.

Find where a boy must place his weight in order to lift a certain object, as the desk.

What will be the effect of moving the fulcrum farther from the object? Why?

Where must two boys each the weight of the first put their combined weight to just lift the object?

Where must a boy half as heavy as the first put his weight to lift the object?

Using the ruler as a lever show how it could be used to the greatest advantage in rolling a heavy log.

Discover the application of the lever in the use of the claw-hammer, wrench, button-hook, auger.

If a boy weighing eighty pounds places his weight ten feet from the fulcrum, the weight lifted being two feet from the fulcrum, find the weight.

Other easy problems may be given.

For additional work require the pupils to practise with a lever, moving different objects and using it in as many ways as possible. They should also be required to observe ordinary machines and appliances, and discover in these as many practical applications of the lever as possible.

Other ordinary examples are:—scissors, pen-knife blades and pump-handles.

LEAVES.

Secure, with the aid of the pupils, sprays of maple, elm and horse-chestnut.

It is taken for granted that pupils have had a lesson on the parts of a leaf, as blade, petiole and stipules.

I. Relation to Sunlight.

On what part of the plant were these leaves found? Where were they growing, with relation to the ground? What is their color?

Examine grass-leaves that have been covered by a board for a few days. What is their color?

Place a house-plant (geranium) in darkness for eight or ten days. Observe the changes that take place.

From these observations infer the relation of the green color of the leaf to sunlight.

Compare the form of leaves with that of the stem of the plant.

In house-plants, shrubs and trees observe what position the leaves generally take relative to sunlight.

From observations of the *position*, *color* and *form* of leaves infer the one essential condition of their healthful activity.

The teacher should emphasize the fact here that the life-work of the leaf depends on sunlight.

Examine a spray of the maple. Compare the different leaves on the spray as to (1) *shape*, (2) *size*, and (3) *length* of petiole.

Supposing all the leaves on this spray were of the same size and with petioles of equal length, what would be the effect on some of them relative to sunlight?

Assuming sunlight to be necessary to the life of the leaf account for the varying sizes of the blade and the difference in length of the petioles.

Examine the leaves of a house-plant, as a geranium or shamrock grown in window light.

What is their position relative to the sunlight entering the window?

Turn the pot around and after some days note changes in the position of the leaves.

Infer the cause of this change of position.

II. The Life-Work of the Leaf.

This presupposes that the pupils know the absorptive and conducting functions of the root.

Place a vigorous leaf (freshly cut) so that its petiole pierces a piece of cardboard and immerses itself in water contained in a tumbler. Cover the blade with another tumbler inverted and resting on the cardboard. After some time examine the inner surface of the upper tumbler.

What do you observe?

Where has the moisture come from?

Where does the leaf on the stem obtain water?

Observe the effect on the leaves of withholding water from a potted plant.

From the above experiment account for the withering of the leaves of the potted plant.

Give the term *transpiration* and inform the class that the moisture is evaporated from the leaf through very minute openings or mouths found in the covering of the leaf, and which are usually more numerous on the under side of the leaf.

Place a vigorous leaf with its blade immersed in a tumbler of water, and set the glass where there is plenty of direct sunlight. After an hour or so examine the leaf. What do you observe rising from and on the surface of the leaf?

Now set the glass with the leaf in darkness and after an hour examine it again.

Compare this observation with that made when the glass and leaf were in sunlight.

Again, place the glass with the leaf in direct sunlight and after some little time observe what takes place.

From these observations infer the condition for this activity in the leaf.

The teacher should now inform the class (1) that the little bubbles found on and rising from the leaf in sunlight are oxygen, and (2) that this evolution of oxygen gas is an indication of a work being performed by the leaf in the process of digesting its food.

Have a couple of fruit-jars with closely-fitting tops. Burn a candle in one until it will burn no longer. Re-light it and again place it in the jar. What is the result?

Place in this jar, containing a little water and the product of the burned candle, a few sprays of mint. Seal it and set it aside for two or three days in the sunlight. Then test the gas within the jar by lighting a candle and placing it in the jar. What is the result? Is the gas in the jar the same now as that in the jar when it was set away? What leads you to this conclusion?

In the meantime experiments should be performed, such as testing the product of combustion and of human respiration with lime-water. The similar results will lead pupils to infer that the gas formed in the jar by burning a candle, and that breathed out in every expiration by man and other animals, is the same, viz., carbon dioxide.

The teacher should also inform the pupils that the gas which enables the candle to burn is oxygen, and that oxygen is produced, and carbon dioxide is assimilated, in the little cells of the leaf through the action of small, green bodies in the cells, which give the green color to the leaf.

From these experiments what do you infer to be one of the foods of the leaf?

What gas in the process of food-digestion is given off into the air?

From these facts infer the effect of growing-plants upon the air of a room.

What three facts have been learned about the work of the leaf?

III. Relation Between the Leaf and the Root.

Examine the position of the leaves of the turnip, beet, radish and rhubarb.

What is the course of the collected raindrops or the trickling dew on the surface of these leaves?

What relation do the creases in these leaf-blades bear to this course of the water?

Now, examine the roots of these plants.

What course do they take in their growth?

Infer a reason for this.

Examine the position of the apex and base of the leaves of maples, elms and willows.

Generally which is on the higher level?

Infer the course taken by rain-water on such trees.

Examine the roots of these trees and state the direction of their growth.

Infer why their development should be lateral rather than vertically downward.

From these observations what general conclusion can be drawn with reference to the relation between the position of the leaf and the direction of the development of the roots?

IV. The Relation of the Position of the Leaf to the Light.

Examine the leaves of an erect, unbranched plant such as the mullein.

What is the position of the lower leaves relative to the stem?

What are the positions of the leaves higher up the stem?

What would be the effect relative to sunlight of all the leaves having the horizontal position of the lowest leaves?

What adaptation of the leaf to sunlight is effected in this plant?

Compare the leaves on the same mullein stem as to size.

What adaptation to environment is evident in this difference of size?

Make similar observations upon the shepherd's-purse.

Make a list of plants in which you have discovered similar adaptations.

Examine the leaves of the prickly-lettuce or wild-lettuce.

How does their position relative to sunlight compare with that of the mullein?

Account for this modification.

The teacher should impress at each step in plant-study that all modifications such as this are not due to accident, but are rather definite modes of adjustment to environment.

V. Relation between Width of Leaf-blade and the Number of Vertical Whorls on an Erect Stem.

Examine the leaves of the sunflower and the lily. Compare their leaves as to (*a*) proportionate length of blade, (*b*) width of blade, and (*c*) mode of attachment.

How do the number of vertical whorls of leaves in the one compare with that in the other on the same length of stem?

Make similar observations on the leaves of other erect plants.

What is your conclusion with respect to the relation between the width of the blade and the number of vertical whorls on the erect stem.

Make a list of plants observed in this respect. What adaptation here becomes evident?

VI. Relation of Length of Petiole to Leaf-position.

Examine the bellflower *(Campanula)*, or early saxifrage, from the direction in which the sunlight strikes it.

Describe its appearance from this view-point.

Account for the formation of this rosette of leaves.

What purpose is served by its having the lower leaves with long petioles and the higher ones with shorter ones?

Similarly, observe the leaves of the begonia, a common house-plant cultivated for its foliage.

Make a list of plants in which you have observed a similar adaptation.

SEEDS.

Procure a number of common white beans and peas. Soak some of each for a day before examining them.

I. External Markings.

Observe an unsoaked bean. Describe its color, shape and surface.

Examine the surface to discover a part different from the rest. Find a corresponding part in a pea.

At the first opportunity examine a green pod containing beans or peas and infer the cause of this scar.

With a lens discover a minute orifice near the scar.

Teach the term *micropyle.*

Discover also a small protuberance near the scar. Describe its position relative to the micropyle.

II. Parts of a Seed.

With a needle or sharp knife remove the covering from a bean which has been soaked for a day. Where is the coat connected with the rest of the seed?

Separate the inner part of the seed. How many parts do you find? Describe the form and position of each part.

Give the terms *cotyledons*, *caulicle* and *plumule*, and inform the pupils that these three together make the *embryo* of the seed.

Draw (*a*) the embryo in different positions; (*b*) the embryo with one cotyledon cut away so as to show the caulicle and plumule; and (*c*) the caulicle and plumule as seen under a lens. Name each part as it is drawn.

Examine the pea and compare it as to markings and contents with the bean.

Draw the parts observed as in the bean.

III. Kinds of Dicotyledonous Seeds.

Treat the castor-bean in a similar manner and examine it as to color, shape, external markings, number and kinds of coats.

How many parts are found within?

Describe the form and relative position of each part.

Draw the parts and name them as in the case of the bean and pea.

The pupils will likely mistake the two large bodies within the seed for cotyledons. By carefully removing the two thin cotyledons show them that there are parts found in this seed which are not in the bean or pea.

Where are the cotyledons situated relative to the two whitish bodies?

Describe the parts found in this seed which are not in the bean or pea.

..ve the term *plant-food*, or *albumen*, according to the advancement of the class.

In what respects are all the seeds examined similar?

In what respects are they different?

How many cotyledons are found in each.

Give the term *dicotyledon*.

What was found in the castor-bean that was not found in the common bean or the pea?

Give the terms *albuminous* and *exalbuminous* if the class is sufficiently advanced.

Examine other seeds such as the squash, sunflower, almond, maple, buttercup, etc., and compare them with those already examined. Classify them as albuminous or exalbuminous.

IV. Monocotyledonous Seeds.

Treat Indina-corn in a similar manner to the seeds examined.

Describe the external features of the grain.

Make a longitudinal section perpendicular to the flat sides and through the middle of the grain which has been soaked for a day or more. Observe the strong external covering composed of the united coats of the seed and fruit.

Make a drawing of the cross-section.

Strip off the entire covering from the paler face of the soaked grain and remove the whitish body lying on the face of the grain.

Of how many parts is it composed?

Describe each of these parts as to form and relative position.

Make drawings of these and name each part shown.

How many cotyledons are present?

What is found within the seed-coats in addition to the embryo?

What seed does it resemble in this respect?

Because of this characteristic to which class of seeds does it belong?

In what respect does the embryo of Indian-corn differ from each of the seeds previously examined?

Teach the term *monocotyledonous.*

Examine similarly onion-seed, wheat, etc., and compare with Indian-corn.

Have pupils plant several seeds of the kinds examined and watch their development with a view of determining the function of each part.

ICE AND MICA.

A lens and hammer are needed for work connected with rocks and minerals.

Each pupil will have specimens of the minerals before him.

In what respects are ice and mica different from all animals and plants that you have seen?

Report observation upon the source of each of these two minerals.

Are they solid or liquid?

Which is the more glittering or shining?

Teach the terms *lustre* and *lustrous.*

Scratch each with a knife or wire nail. Note differences in the streaks made.

Compare the color of ice and mica.

Which is more transparent?

Try to scratch mica with ice and ice with mica, and from this infer which is harder.

Try to break each, and infer which is more brittle.

If possible bend each, and judge which is more flexible.

By bending, twisting or altering the shape in any way, ascertain which returns to its original form more readily and more completely, and infer which is the more elastic.

Note the difference in the way in which they split. Give the term *cleavage.*

Place both in water to find out which is heavier.

Apply heat to each, and infer which can be melted more easily.

From the qualities you have tested infer the uses of each.

LIMESTONE.

The teacher should have specimens of limestone to show the pupils, so that they may recognize it in their outings.

This stone is widely distributed in Canada, and may be found almost everywhere in southern Ontario, either as boulders in the fields or in "place" along some stream, lake shore, or in some quarry.

When pupils are directed to look for specimens of limestone, they should be enjoined to observe the situation where the specimens are found. If a limestone quarry is in the neighborhood the teacher should visit it with the pupils and teach, as far as circumstances will permit, the terms *stratification*, *fault*, *outcrop*, *dip*, *strike* and *fossil.*

Can you scratch limestone with your finger-nail?

Draw the point of a pocket-knife forcibly over a piece of limestone Does the knife scratch the stone? From this infer which is harder, iimestone or steel.

The teacher should have some fossils to show the pupils, so that they may recognize similar remains when they are found.

Examine the specimens to discover fossils. Compare, if possible, with similar forms now living. Are they shells, corals, trilobites, etc.? Describe the fossils found. Are any of these forms still living? Where do their nearest relatives now live?

Infer whether limestone was formed under water.

If these rocks were formed beneath the sea, what changes must have taken place in the level of the land?

Examine a piece of limestone with a lens. Describe its appearance. Are there any crystals in it?

Weigh a piece of limestone, then place it in a fire till it is red hot. As soon as it is cold, weigh it again and note the difference in weight. What change has taken place in the limestone?

Teach the term *quicklime.*

Wet the quicklime with a little water. Describe what happens. Note the change of temperature. Take a little sulphuric acid and add its own bulk of water. Note what happens. Why? What causes the rise in temperature when water is added to the quicklime?

Put a piece of red litmus-paper on moist limestone and then on the moistened quicklime. What happens in each case?

Give the term *slacked-lime.*

Where have you seen slacked-lime used?

What use was being made of it?

Have you ever seen limestone burnt on a large scale?

Give the term *lime-kiln.*

What use is made of unburnt limestone?

If there are any limy springs in the neighborhood pupils should be asked to observe them to discover if limestone is now being formed.

Travertine, "petrified moss," is formed by such springs in most parts of southern Ontario.

Describe the appearance of such limestone. Compare it with the old limestone. Discover whether there are similar fossils in it.

Discover if it will burn into quicklime.

GOLD QUARTZ.

The teacher should have some specimens of quartz crystals, quartz with gold grains visible in it, iron pyrites and chalcopyrite, to enable the pupils to recognize these minerals when they meet them.

Describe the appearance of quartz.

What does quartz closely resemble in appearance? Try to scratch it with your knife and then try to scratch the knife with the quartz. Infer from this which is the harder of the two.

Try a similar experiment with a piece of glass and quartz. Again infer which is harder, glass or quartz.

Break a piece of quartz into fine particles; compare these with sand. Infer from what kind of rock sand is formed. Compare also with the sand on coarse sand-paper.

Why is sand-paper useful?

Heat quartz red-hot and cool it. Discover whether it will slake like limestone. Strike a piece of quartz against steel and discover what happens.

Examine a piece of gold-bearing quartz to discover other minerals than the quartz.

Such generally has gold and iron pyrites.

What is the color of each of these?

Discover which is harder, your knife or iron pyrites.

Discover which is harder, quartz or iron pyrites.

Powder and strongly heat some iron pyrites. Describe what happens.

Observe the smell while the pyrites is being roasted and infer what substance is being given off.

Describe the material left and note its color.

What has passed off from the pyrites? Why is the powder that is left rusty?

Try to cut a piece of gold with a knife and to flatten it with a hammer.

Give the terms *malleable* and *malleability*.

Compare gold and iron pyrites as to hardness and malleability.

Heat gold and compare its smell then with that of iron pyrites when heated.

Select pieces of quartz, pyrites and gold of nearly equal size and discover which is heaviest and which is lightest.

Weigh a bit of quartz, first in air, then tied by a hair to the beam of the balance in a glass of water. Subtract the weight in water from that in air. Divide the weight in air by the difference between the two former weights. The quotient will be the weight of the quartz as compared with that of an equal volume of water.

In a similar way determine the specific gravity of iron pyrites, and, if there is gold enough for the purpose, also of gold.

Compare the specific gravities of gold, iron pyrites and quartz. Infer from this why gold is found in the layer of sand resting on the rock in the beds of creeks in some gold-mining regions.

THE HUMAN BODY.

I. Its Beauty.

Direct the pupils to observe the bodies of one another and to examine their own when undressing. Note the beautiful curves, the symmetry of form and the rhythm of movement.

II. Its Individuality.

Observe the marked individuality of each human being. Note the different complexions, the different

colors of the hair, etc. Notice (*a*) that each person has been especially designed to fill a place no other can fill; (*b*) that this responsibility should make us dignified and thoughtful.

NOTE 1.—Observe that people frequently bear a marked resemblance to each other, and discover that individuality is more marked from within than from without. The body is simply the house in which we live.

NOTE 2.—Different countries have different races of peoples with characteristics markedly different from those of our own country. Show, if possible, a picture of these races.

NOTE 3.—The skeleton of the body, if available, may be shown.

III. Its Divisions.

Observe the four natural divisions of the body—head, trunk, upper extremities, lower extremities. Discover how the head and extremities are joined to the trunk and the most apparent use of each.

Emphasize the beauty of the body, and the adaptibility of part to part, and of the whole body to the work of man.

The body will grow and strengthen only through exercise. Note different kinds of exercise.

(*a*) HEAD.

Examine the head. Note the different curves; how the arch shape at the top gives strength; discover what is considered a finely-shaped head; name the different parts and the special use of each.

Observe the hair on different heads. Note the different colors, textures. Infer its use. Note the best means of preserving it. Discover how one can tell the root-end of the hair. If possible examine a hair with a microscope and determine how the parts are arranged.

Examine different faces. Note their shapes. Compare these, if possible, with pictures of faces of different races of people. Discover (*a*) the only movable part; (*b*) the bones that give the most marked outline to the face. Name and give the position of the different parts of

the face. Using a mirror examine the inside of the mouth. Describe the parts observed.

(*b*) TRUNK.

Observe its general shape.

Note the suggestiveness of the name.

Infer its use.

Describe its framework.

Discover what prevents this part of the body from being jarred.

Teach little children the following terms:—*Spine, breast-bone, ribs, chest.* More advanced pupils should be taught the following terms:—*Vertebra, vertebræ, sternum, thorax, abdomen, pelvis.*

(*c*) UPPER EXTREMITIES.

Observe the three divisions (upper arm, fore-arm, hand) into which each of the upper limbs naturally falls.

Move the arm in different ways. Feel the joints.

Discover the different kinds of joints. Name them.

Teach little children the following terms:—*Collar-bone, shoulder-blade, wrist, hinge-joint, ball and socket-joint.* Teach older pupils the names of the different bones and how these bones are related and arranged so as best to serve the body. The use of a skeleton will be helpful here.

(*d*) HAND.

Observe the divisions of the hand, fingers and wrist. Discover how they are joined to one another.

Note the different movements of the wrist and fingers.

Compare these movements with those of the arm-joints.

Teach the term *knuckles.*

Examine the finger-nails.

Discover their use.

Elicit observations showing the adaptibility of the hand, especially if trained, to doing different kinds of work.

Compare the hand of man with the substitutes used by different animals.

(*e*) LOWER EXTREMITIES.

Observe the divisions of the lower limbs—thigh, leg, foot.

Discover how these parts are joined to one another.

Teach little children—hip, knee-pan.

Teach more advanced pupils the names of the bones.

Observe the way in which the different joints move.

Discover the advantage in each case. Compare the knee-joint with the elbow-joint.

Observe the erect position given to the body by the position of the lower extremities.

Discover how this position is the best for man.

Note how it tends to give dignity and superiority.

(*f*) FOOT.

Observe the divisions of the foot, the ankle, the heel, the sole, the arch or instep, and the toes.

Compare these parts with those of the hand.

Examine the joints of the toes.

Compare the number, position and movement of these joints with those of the fingers.

Examine the toe-nails. Infer their use.

IV. Its Covering.

Examine the skin and note the following: (*a*) its beauty, (*b*) its work.

Infer why it should be kept clean.

V. Its Frailty.

From observations made infer (*a*) the frailty of the body, (*b*) the necessity of knowing how to keep it healthy.

VI. How to Take Care of the Body.

Have simple talks on the following :—

Bathing the Body:—When to bathe, kind of water to use, how to dry the body, the importance of rest after bathing.

Feeding the Body:—Kinds of food (*a*) for winter, (*b*) for summer; how to prepare the most common foods. How to make porridge, how to toast bread, how to cook eggs, how to make a cup of tea, how to boil potatoes, how to cook beefsteak, how to cook rice, etc.

Clothing the Body:—Proper kinds of clothing (*a*) for winter, (*b*) for summer.

Wool, cotton, silk, emphasizing their effect on the body when used as articles of clothing.

What to do in the following emergencies:—

(*a*) If a child cuts his finger.

(*b*) If he breaks his arm.

(*c*) If he faints.

(*d*) If he bleeds at the nose.

(*e*) If he falls into the water and is taken out apparently drowned.

Feeling.

I. Sense of Touch.

Try, by touching them, to distinguish certain things, as an apple, an orange, sugar, a pen, a pair of scissors.

II. Nerves of Touch.

Discover:—(*a*) In what parts of the body the sense of touch is located; (*b*) the advantage in having all the parts of the body sensitive to touch; (*c*) the parts of the body where the sense of touch may be considered the most delicate. Infer the advantage gained because of this location.

III. How to Cultivate the Sense of Touch.

In this, as in the cultivation of other talents or powers, "we learn by doing."

1. Have a number of objects of different degrees of smoothness and let the pupils find (*a*) the smoothest, (*b*) the roughest, (*c*) two of the same degree of smoothness.

2. Place a number of objects of various shapes on the desk, each shape being represented by two or more objects. Blindfold a pupil and place one in his hand and have him find another of the same shape.

3. Have the child put his hand behind him and place objects of various shapes in it and have him tell their names.

4. While looking away or with his eyes blindfolded let a child tell the number of objects by feeling them.

5. Have thread and cord of various degrees of fineness and have pupils discover by the sense of touch which is the finest, which the coarsest, etc.

6. Blindfold a pupil and lead him to different objects in the room and ask him to name them from feeling them.

7. After the leaves of the more common trees are studied by means of both eye and hand, have the pupils blindfolded and let the leaves be identified by touch alone.

How does a blind man learn to read?

What is the effect of practising any art from day to day?

NOTE 1.—The hand is the most perfect instrument known; indeed, it may rather be called a set of machinery.

Instruments or tools, as a spade, saw, axe, chisel, gimlet, do only one thing. The hand can do many different kinds of work. The same hand that can wield a blacksmith's hammer can handle a pen, or can use the tools of an engraver. No machine made by man can do both coarse and fine work. The hand can grasp a rope firmly, or take between finger and thumb a thread so fine that it can hardly be seen.

Only man has a hand. A monkey has something like a hand, but the thumb, especially, is different.

So delicate is the sense of touch in the finger-tips that the blind make hands serve the place of eyes.

NOTE 2.—By way of adding interest discover where the sense of touch is most highly developed in different animals.

(*a*) Animals with hoofs—lips and tongue.

(*b*) The cat and its relations—feelers.

(*c*) The elephant—end of trunk.

(*d*) The insect—antennæ.

NOTE 3.—Some authorities designate certain kinds of feeling by the name of muscular sense; indeed, they term it a sixth sense.

This so-called sense can be very highly cultivated. Give examples of people who are handling objects of different weights: the grocer, the butcher, the farmer, etc.

The teller in the bank has this sense so well trained that he can immediately detect the difference in weight of a false coin.

Sometimes the sense of touch is lost, then the eye takes its place. If this sense were lost, we could not walk across the room with our eyes closed, nor could we hold things for any length of time without looking at them. People who perform feats of physical strength have this sense very highly trained.

When people are blind the muscular sense becomes very acute.

HEARING.

I. How we Know Sound.

1. Ask pupils to distinguish sounds with which they are familiar.

2. Allow them to try to distinguish unfamiliar sounds.

Observe that the hearing is as acute in the one case as in the other.

Infer that another power—the mind—works through the sense of hearing, and that in the second exercise the mind had not the required information.

II. How Sound Travels.

1. Strike the end of the table while the child listens at the other end.

2. With a pin or nail scratch the end of a ruler or long pointer and put the other end to a child's ear. Have the child note the effect.

3. Fasten a silver spoon to the middle of a string. Put an end of the string in each ear. Then slightly swing the spoon until it touches the edge of the table. Note the effect.

4. Procure two opened cylindrical fruit-cans. Pierce a hole in the bottom of each. Connect the cans with a string sixteen or eighteen yards long by passing it through the holes and fastening it on the inside. Speak into one of the cans and let a pupil listen with the other at his ear and note the result.

In each of the above cases observe the following:—

(*a*) The point at which the sound was produced.

(*b*) The distance at which the sound was heard.

(*c*) How the sound must have reached the ear.

III. Vibrations of Sound.

Note a large bell when ringing.

1. Observe it with eye and state what you discover. Touch it; note what you observe.

2. Fix a flexible steel needle firmly in a cork which will give it sufficient support. Then fasten at the upper extremity a ball of sealing-wax or a piece of paper about the size of a pea. Hold the cork firmly in one hand and strike the needle till you cause it to vibrate. Describe the movements of the wax or paper. Strike the needle with greater force and state what you observe.

3. Throw a stone into the water.

Observe the effect.

4. Move the hand quickly through the air.

Observe the effect.

Compare the effect on air with that on water.

Discover from the above experiments the power of vibrations to move particles of different kinds.

Discover also that the wave-vibrations grow smaller and smaller until they die away altogether.

IV. Sound can be Collected.

1. Observe that sound can be heard better in a building than in the open air.

Discover the reason.

2. Listen for the echo.

Note places where the echo is best heard.

Discover the cause.

3. Observe the shape of the ears of certain animals that discover their prey by hearing.

Infer the purpose of the shape.

4. Place the hand behind the ear.

Listen for different sounds.

Note the effect.

Discover why the hearing is better.

5. Examine different kinds of ear-trumpets.

Discover why they are thus formed.

V. Time Necessary for Sound to Travel.

Observe a carpenter at a short distance away driving a nail.

Note that a certain time elapses between the time the nail was hit and the time at which the sound was heard.

Infer the reason.

The rate at which sound travels and examples may be given to advanced pupils.

VI. The Organ of Hearing.

Examine the outer ear.

Observe (*a*) the beauty and adaptation of its form; (*b*) its shape as seen in different people.

Note the entrance to the inner ear, and how this entrance is protected.

Describe the ear, noting, in the description given, each of the above points.

Draw the outer ear.

The teacher should draw an inner ear and describe the following parts: (*a*) drum; (*b*) chain of bones; (*c*) the second drum, with small bones attached; (*d*) the winding passage containing fluid; (*e*) nerves.

Lead pupils, after the above instruction, to discover the use of each part.

VII. Power to Hear.

Observe that frequently sounds are within our hearing but we do not notice them.

Discover the reason.

VIII. How to Make Hearing more Acute.

1. Endeavor to distinguish different sounds.

Observe that the more intent the mind is on the sound the more likely we are to distinguish—

(*a*) The rustling of leaves.

(*b*) The singing of a tea-kettle.

(*c*) The patter of rain.

(*d*) Different whistles.

(*e*) Different calls.

(*f*) Songs of birds.

2. Try to imitate the following :—

The different sounds made by the cat, dog, lamb, duck, hen, crow, robin, cow.

3. Try to learn by ear simple tunes.

4. Try to imitate the voices of different people.

Strike the same object with hammers of different weights with equal velocity and note the effect. Which hammer caused the loudest noise?

Let a pupil place his ear at the end of a long piece of timber or board. Scratch the other end slightly with a pin. Note what happens.

Let him remove his ear while the scratching is continued and note the difference.

When an approaching train is yet a mile or more distant place the ear against the iron or steel rail. What is observable? Stand up and notice whether the train can be heard.

Infer whether sound is conveyed more readily through air or through a solid.

NOTE.—The loudness of the sound often depends upon the condition of the air where the sound is first started. Balloonists have heard sound twenty thousand feet from the ground, but sometimes even in a shorter distance, as across the river, the sound cannot be heard. If a drum is beaten on the opposite side of a river covered with snow and ice, when the atmosphere is thick, the sound cannot be heard on the other side; the vibrations have been absorbed.

TASTING.

I. Sense of Taste.

1. Try to distinguish by the sense of taste different things, such as sugar, salt, oatmeal, tea, soap, tar, sweet apples, sour apples, etc.

2. Tell how each tastes. Which thing has the most agreeable taste.

3. Observe that tastes differ. Discover to what this difference is due. Discover also whether there is any standard for correct taste in food.

4. Note in each of the above tests that the mind works through this sense as it does through the other senses.

II. Organ of Taste.

Discover what part of the tongue is really the most susceptible to impressions made by different substances taken into the mouth.

Draw the palate.

Draw the tongue.

III. Pleasures of Taste.

(*a*) Note the satisfaction and enjoyment we gain from eating that which pleases our taste.

(*b*) Wholesome food may often be tested by this sense.

(*c*) Food is frequently selected because of its taste.

NOTE.—Animals frequently choose their food by tasting it.

IV. Comparisons of Different Tastes.

(*a*) Compare different kinds of acid fruit.

(*b*) Different kinds of sweets.
(*c*) Substances that are bitter, insipid, pungent, etc.

SEEING.

I. Sense of Sight.

1. Hold up objects familiar to the class. Ask pupils to name them.

2. Present objects unfamiliar to pupils. Try to name these objects.

Note that the vision is equally strong in both of these observations.

Discover why the information asked for in the second case cannot be given.

II. The Organ of Sight.

Examine the eyes of different people.

1. Observe their different colors; their different expressions.

Note the different parts—name them.

Describe each part and discover its use.

Draw an eye.

2. Observe how carefully the eye is protected.

From observations made infer that it is exceedingly delicate.

3. Note (*a*) that certain habits strengthen and help to preserve sight; (*b*) that certain habits injure the sight. Observe these different habits and discriminate between them.

III. Source of Light.

Observe the sun as the source of light.

Examine rays of light as seen through cracks and knot-holes.

Discover the direction in which light travels.

Note that the light of the sun (or a substitute) is necessary to reveal to us through our sense of sight the objects around us.

IV. Reflection of Light.

1. Note the effect of light upon different surfaces (*a*) a glass mirror, (*b*) polished metal, (*c*) the floor, (*d*) a black cloth.

Discover that some surfaces reflect light more readily than others.

2. Observe images in a mirror, shadows in the water.

Discover that some surfaces are better reflectors than others.

3. Compare the eyes with a mirror.

Observe the image formed on looking into another eye.

Infer that images of other things are formed in a similar way.

V. Power of Sight.

From observations made infer the following :—

(*a*) We do not see the things around us, though they are within the range of our vision, because we do not bring the mind to bear upon them.

(*b*) Our sight must be trained.

(*c*) The eye has wonderful powers of adaptibility.

Compare the power of the human eye to see with that of eyes of animals. Infer why a cat can see where we cannot.

VI. How to Train the Sense of Sight.

1. Hold up quickly certain articles before the class and have them numbered and named at once.

2. Write a word upon the blackboard and have the number of letters in it given.

3. Put a column of figures upon the board and have the number given.

4. Expose a collection of articles for an instant and have them named.

5. Have objects observed on the way to school named.

Discover from the above that the more intent the mind is upon an object the more the sight can find in it.

The more we know the more we see in things, or "We see through that we have already seen."

Infer from the above that by constantly trying to observe whenever and wherever we are, we can train ourselves to perceive better.

SMELLING.

I. Sense of Smell.

Let us see whether we can discover the names of some things by their smell.

1. Try to name certain things used for food—sugar, dried fruit, oatmeal, pickles, onions, oranges, toast.

2. Try to distinguish certain flowers (the flowers to be used may be shown to the children first).

Note the relation between the sense of smell and the mind.

II. Organ of Smell.

Observe the noses of different people and note.

(*a*) How the nose adds beauty to the face.

(*b*) How the shape and size differ on different people.

III. Uses of Smell.

Allow pupils to smell certain things (*a*) that have an agreeable odor, (*b*) that have a disagreeable odor.

Infer that this sense frequently protects man in selecting food and in warning him against danger.

Note also the enjoyment we get from this sense.

The sense of smell protects us from a great many harmful things. We know odors arising from decaying bodies or filth. Often, by the smell, we can tell that we are in a most unhealthy locality, though we cannot see anything that would give us warning. Then, too, this sense gives us a great deal of enjoyment. Who does not enjoy the smell of the sweet hay, the freshness of the morning, the perfume of the flower, the salty breeze from the seas?

IV. How we Smell.

No amount of investigation on the part of the child can discover how we smell. Information may be given somewhat as follows:—You smell a flower. The fragrance is agreeable, but you cannot see the fragrance. What, then, is it? It is really due to very fine particles, finer than the very finest powder, floating about in the air, and going with the air into your nostrils. There are a great many folds in the nose, which can thus present a great deal of surface to the fine particles. In the lining of the nose are very fine nerves. These little particles stimulate the nerves. The nerves convey the stimulus to the brain. The mind then knows it as a sensation of smell, compares it with other sensations and finally becomes conscious of its exact nature.

V. Sense of Smell in Animals.

Observe how the different animals make use of this sense.

Some quadrupeds, insects, and birds, have this sense very highly developed. The dog can trace his master many miles by scenting his footsteps. Insects love the odorous flowers. Carrion birds know where to go for food by following the guidance of this sense.

VI. How to Train the Sense of Smell.

1. Have pupils examine such objects as the following and observe their odors:—Apples, pears, oranges, lemons, pineapples, pepper, celery seed, caraway, sage, etc.

2. Blindfold the pupils, and, from observing their odors, have objects named, as chamomile, ginger, lemon, pepper, etc.

3. After pupils have studied plants and their flowers have them blindfolded and the flowers named from their odors.

Correlation of Different Subjects through Nature-Lessons.

In schools where Nature-study is pursued, opportunities, otherwise impossible, present themselves for the correlation of the different subjects through the information obtained from investigations and observations in Nature. Yet such opportunities count for little unless there is definiteness of plan. In the primary class, indeed, special care is absolutely necessary, for here no one subject can entirely exclude another. Each is in all and all in each. However, much confusion frequently arises because there is no definite plan or no definite basis on which to unify.

A.

Reading.—Nature-lessons on the cat have been given. A class beginning to read is before the teacher. He may proceed somewhat as follows :—

1. Let each little child in the class be prepared to express in words a thought giving some information about the cat.

2. After a few minutes' silence, by way of allowing the pupils to consider what they are to say, call upon the different pupils to express their thoughts in words.

3. Write each of these thoughts upon the blackboard.

Be sure to emphasize the fact that these are the thoughts just given by the pupils but expressed in another way.

It will be found helpful to write the names of pupils, respectively, opposite thoughts expressed by them.

THE CAT.

The cat has five toes on each of her fore-feet.	(Willie.)
The cat has a soft fur coat.	(Ella.)
The cat has little cases for her claws.	(Sara.)
The cat's tongue is covered with hooks.	(Charlie.)
Some cats are grey.	(Grace.)

Some cats are black. (Ethel.)

The cat can lap up milk. (John.)

4. Ask each child to read his own thought as expressed in writing.

5. Ask Ella to read Willie's thought, Willie to read Charlie's thought, etc.

6. Draw attention to the order of the above and re-write. Thus—

The cat has five toes on each of her fore-feet.
The cat has a little case for each claw.
The cat's tongue is covered with hooks.
The cat can lap up milk.
The cat is covered with fur.
Some cats are black *and* some are grey.

7. Draw attention to the repetition of the word cat; emphasize the use of the pronoun and re-write. Thus—

The cat has five toes on each of her fore-feet.
She has a little case for each claw.
Her tongue is covered with hooks.
She can lap up milk.
She is covered with fur.
Some cats are black and some are grey.

Re-read and compare.

COMPOSITION.—After a few reading-lessons like the above the following might be required:—

1. Express in writing five thoughts giving information about the cat.

B.

The reading-lesson may take the following form:—

1. Let each little child in the class be ready (*a*) to ask a question about the cat, or (*b*) to give a command to the cat, or (*c*) to express surprise about the cat.

2. Proceed as in reading-lesson "A."

Write several questions or several commands down. Emphasize punctuation and expression.

COMPOSITION.—After the reading-lesson "B" give the following :—

1. Express in writing five sentences asking information about the cat.

2. Write five sentences giving your pussy a direct command in each.

3. Write five sentences each expressing surprise or indignation about your cat.

C.

The Reading-lesson may be still more limited.

1. Let each little child frame a thought about

(*a*) The habits of the cat, or

(*b*) The structure of the cat, or

(*c*) The relations of the cat.

COMPOSITION.—Proceed as in reading-lessons "A" and "B," emphasizing consecutive thought, the paragraph and the title of the lesson.

1. Express in writing two thoughts on each of the following habits of the cat :

(*a*) eating and drinking,

(*b*) sleeping,

(*c*) washing,

(*d*) hunting.

2. Express in writing three thoughts concerning the structure of the cat :

(*a*) its covering,

(*b*) its feet,

(*c*) its head—eyes, teeth, whiskers, tongue.

The thoughts of the different pupils may be written on the blackboard, and pupils asked to read one another's sentences. Note the best forms of expression and the best order of arrangement.

D.

The reading-lesson may be made to take still another turn. This time call the imagination of the child into play.

1. Let each little child frame a thought on the following points and be ready when called upon to express it in words :—

(*a*) *Pussy is without a home.* She has been left on the streets of a crowded city, her mistress having gone away for holidays.

(*b*) *She is hungry.* What she does.

(*c*) *Bad boys stone her.* Where she climbs—how she climbs—time she hides.

(*d*) *Night comes.* What the cat does—where she gets food—the kind she gets—how she eats it.

(*e*) *Pussy finds a home.* Where? Who takes care of her?

2. Proceed to express each thought in writing as in lessons "A," "B," "C."

3. Allow pupils to select a suitable title for the lesson.

COMPOSITION.—As in the reading, headings may be given calling the imagination into play, thus :—Express in writing your thoughts on the following :—

The Way the Cat Rescued her Kittens. (*a*) A dog chased them. (*b*) Puss followed them. (*c*) Where she found them. (*d*) How she carried them home. (*e*) The place she hid them.

E.

READING.—A simple lesson like the following may be composed by the teacher, containing, as this does, information not definitely dealt with in the Nature-lessons proper, but information which the child has been prepared to receive and which he can gather for himself.

THE SORROWFUL CAT.

"My child! what's the matter?" said Mrs. Puss to her little black kit.

"O mamma, the calf hurt my foot! mew, mew."

"Hush, my dear! mew, mew," said the mother, licking the sore foot. "I told you not to go to the field alone."

The little puss was quiet for a moment and then said, "I ran after a little mouse, mother."

"Children should obey their parents, mew, mew," was all the wise old parent said.

"Mamma, am I a child?"

"Of course you are. You are my dear baby child."

"Is a calf a child, mamma?"

"Yes, my dear."

"But, mother, a calf is not like me. I don't like that old calf."

"O you silly child. Why do you not think? A calf is a cow's baby. A calf does not belong to our family at all."

"Is bunny one of our family? We live with him."

"No; all our family have claws in little cases. They have long, sharp teeth. Their tongues are covered with little hooks. Your cousins the lion and the tiger live a long way from here in the woods. They do not like home life."

"Bunny is the calf's cousin, isn't he, mamma?"

"No, no, dear. Bunny is the pretty squirrel's cousin. He does not look like the calf in any way. Nor does he act like the calf. Sheep and goats are the calf's cousins. The calf will have horns like the cow and the goat when it grows up. It will eat grass and roots too. The feet of all the calf's cousins have parted nails (hoofs)."

"O yes, I know," said little Puss. "The nail is called hoof. Mamma, can you chew like a cow?"

"I am a cat, and I eat like a cat. Cats do not chew."

"A cat is the best, isn't it, mother?"

"Well, well, my child. Your mother is best for you. A cow is very useful. Each thing is best in its place. A cow has its place and a cat has its place. The Great God is all love. He made everything that lives to be happy and useful. He made them all for his own glory."

F.

READING.—A simple piece of poetry on the cat should also be written on the blackboard.

1. It should be read and re-read until the child fully appreciates all there is about it to appreciate.

2. Certain selections and certain stanzas should be committed to memory and a child called upon to recite these to the class.

G.

Read to the class selections from good authors. The following are suggestive:—

"The Kitten and Fallen Leaves."—*Wordsworth.*

"The Retired Cat."—*Cowper.*

H.

Encourage the children to read stories about the cat. Set a definite time apart in which they will be allowed to tell these little stories to one another. Encourage the pupils to criticize the different stories. Encourage them also at times to reproduce in writing these stories, and stories read in their own words. Such reproduced stories may be read before the class.

Music.—Teach songs about "The Cat."

Drawing.—Emphasize drawing during the teaching of Nature-lesson.

Express your thoughts in drawing on the following points:—

(*a*) Pussy sees a bird in the tree.

(*b*) She climbs the tree.

(*c*) The bird flies to the ground and the cat follows it, hiding behind the tree.

(*d*) The cat springs, but the bird flies away.

Note.—The drawings of the position of the body of the cat must be correct under every circumstance mentioned.

Geography.—Pussy has moved with her little mistress to another part of the town. She does not like this new home and finds her way back to her old one.

The new home is on ——— Street. The old one is on ——— Street. Streets familiar to pupils.

1. Tell the different ways (give directions) by which pussy could reach her old home.

2. Draw a map. Showing the different blocks passed, the position of the homes. Mark any homes that are familiar to you on the different streets.

3. Take the globe; show the original home of the cat. Note the seas and lands over which it had to travel to reach Canada.

Spelling.—Pupils who have thoughts and a knowledge of how they should be expressed in written composition find the labor of learning to spell comparatively easy for the following reasons:—

(*a*) The desire to express familiar thoughts in writing is a stimulus to learn to spell.

(*b*) Each word used has a definite meaning and is thus no longer an empty thing.

(*c*) Words can be presented with order and system. Thus:

(1) Write the names of the parts of a cat.

(2) Copy the following:—The cat has sharp, cutting teeth. Some of the relatives of the cat are the lion, the tiger, the leopard, the panther, the lynx, the jaguar, and the American panther.

TOPICS FOR STUDY.

1. It is impossible to make a stereotyped "Table of Topics" for Nature-study.

2. The following tables give suitable topics for the different grades in Public Schools.

3. They are to be used simply as a guide for the teacher. It would be out of the question to cover all the topics suggested.

4. Select from the column as outlined: (*a*) Material suitable for the locality. (*b*) Just what can be covered. Several insects may be found in the Table of Topics as suitable for study; possibly *only one* can be studied. (*c*) It is not necessary to study any topic suggested in the table. Some object in the district which is not mentioned may be more attractive or more beneficial.

CHILDREN WORKING IN GEORGE PUTNAM SCHOOL GARDEN.

(By arrangement with D. Appleton & Company.)

TOPICS FOR THE GRADES.

September. October. November.

AUTUMN PLANTS.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
THE WHOLE PLANT—(general study). Formation of seeds emphasized.	TWO WHOLE PLANTS—(compositæ).	TWO WHOLE PLANTS—Preparation of plants for winter.	TWO WHOLE PLANTS.	TWO WHOLE PLANTS.
FALLING LEAF—Tints. Kinds. Sketch. Make charts.	FALLING LEAVES—Tints; deciduous and evergreen. Sketch main types of leaves.	FALLING LEAF—Tints. Compare with typical leaves. Leaves with defence; leaves we eat; poisonous leaves.	FALLING LEAF—Identification of trees by their leaves.	FALLING LEAF—Leaves of ferns and grasses.
BUDS — Preparation of buds for winter.	BUDS — Preparation of buds for winter.	BUDS—Preparation of buds for winter.	BUDS—Preparation of buds for winter.	
FRUIT (fleshy) — Apple or peach or orange. *Compare—Note resemblances.* FRUIT (dry)—Collection: achenes, grain, nuts, keys, pods.	FRUIT — Apple, peach, pear, plum. *Compare—Note difference.* FRUIT (dry)—Collect as in Part I. Dissemination of seeds (general).	FRUIT—Grape. *Compare.* Collect pods especially. FRUIT (dry)—Dissemination of seeds (emphasize.) Seeds with *down* as dandelion. Seeds with *wings* as ash. Seeds with *hooks* as burdock.	FRUIT—Water-melon. *Compare.* FRUIT (dry)—Collect. Dissemination of *weeds* injurious to crops.	Planting of fall crops.

TOPICS FOR THE GRADES.

September. October. November.

AUTUMN PLANTS—*Continued.*

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
ROOTS AND STEMS—Gather roots good to eat. Sketch. Make model in clay.	ROOTS AND STEMS—Gather and compare different forms of fleshy roots. Sketch. Make model in clay.	ROOTS AND STEMS—Comparison of different kinds of roots. The *potato.* Preparation for spring study.	ROOTS AND STEMS—Special study of plants studied in life-history. Care of tubers, bulbs.	ROOTS AND STEMS—Special study of root. left for seed. Care of winter vegetables.
TREES—General observations. Selection of special trees to be observed in life-history. Trees laden with fruit.	TREES — Special autumn study of maple, nut-bearing tree, fruit tree. Preparation for spring study.	TREES — Special study of shade tree, nut-bearing-tree, fruit tree, that had been noted in spring.	TREES — Same as Third Year. Make new selections. *Comparisons.*	TREES — Particularly forest trees. Wood-study. Uses: Building material, furniture, tools.

December. January. February.

WINTER PLANTS.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
TREES—Evergreen trees. Leafless trees. A potted plant for each child to care for.	TREES—Evergreen trees. Leafless trees. A potted plant for each child to care for.	TREES—Evergreen trees. Leafless trees.	TREES—Evergreen trees. Leafless trees.	AN EVERGREEN TREE—As complete study as possible.

TOPICS FOR THE GRADES.

March. April. May.

SPRING PLANTS.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
SEED-PLANTING— Bean, pea (life-history watched).	SEED-PLANTING— Bean, pea (life-history). Germination.	SEED-PLANTING— Bean, pea, corn (life-history). Germination.	SEED-PLANTING— *Cabbage* (life-history). Wheat (life-history).	SEED-PLANTING— Different kinds of grain.
BUDS AND LEAVES— Buds of fall trees selected, observed. Uses of leaves. Relation of leaves to light.	BUDS AND LEAVES— Branches collected, kept in water. Fall tree selected, studied. (Horse-chestnut, lilac.) Uses of leaves. Relation of leaves to light.	BUDS AND LEAVES Same as First Reader. Comparison of fruit-tree buds with buds of forest trees. Uses of leaves. Relation of leaves to light.	BUDS AND LEAVES —Development of cabbage-leaves. Leaves of *grasses*, flat, keeled or rolled, long or short, blunt or pointed, wiry or succulent, sweet or bitter. Why?	BUDS AND LEAVES —Leaves of agricultural and weed grasses. Shape, size and petiolation of leaves as related to light.
STEMS AND ROOTS— Spring growth of those observed, and drawn in the fall. Work of roots.	STEMS AND ROOTS— Roots of plants and trees selected for life-history. Work of roots.	STEMS AND ROOTS —Comparison of different kinds of roots. Work of roots.	Stems of grasses (color, round or flattened, tall or short). Relation of roots to moisture.	Relation of leaves to roots.

March. April. May. TOPICS FOR THE GRADES. March. April. May.

SPRING PLANTS—*Continued.*

First Reader, Part I. *First Year.*	First Reader, Part II. *Second Year.*	Second Reader. *Third Year.*	Third Reader. *Fourth Year.*	Fourth Reader. *Fifth Year.*
Flowers and Blossoms— Recognition of common wild flowers. Select one for special study—(Hepatica). Blossoms of fall fruit studied.	Flowers and Blossoms Recognition of common wild flowers. Special study — Hepatica, trillium, daisy. Blossoms of fruit and shade trees.	Flowers and Blossoms— Wild flowers. Special study—Violet, thistle, spring beauty. Blossoms of fruit and shade trees (comparison).	Flowers and Blossoms— Wild flowers. Those injurious to crops. Blossoms of fruit and shade trees.	Flowers and Blossoms— Wild flowers (comparison). Family characteristic. Fertilization. Flowers of grasses. Blossoms of forest trees (comparison).
Trees.	Trees selected (life-history). Leaves—function.	Trees selected for life-history. Leaves—functions. *Sap*—use, etc.	Trees selected for life-history. Wood—how formed, use.	Trees. As a Canadian industry.

June. SUMMER PLANTS. June.

First Reader, Part I. *First Year.*	First Reader, Part II. *Second Year.*	Second Reader. *Third Year.*	Third Reader. *Fourth Year.*	Fourth Reader. *Fifth Year.*
Formation of seeds.	Harvesting of grain.	Fruit (fleshy).		

September. October. November.

TOPICS FOR THE GRADES.

September. October. November.

ANIMALS.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
THE RABBIT—(life-history).	THE SQUIRREL—(life-history).	THE COW—Habits, structure.	THE HORSE—Habits, structure, care.	
BIRDS—The hen (life-history). Migration of birds.	BIRDS—The hen and duck (comparison.) Migration of birds.	BIRDS—The crow. Migration of birds.	BIRDS—The wild duck or woodpecker. Migration of birds.	BIRDS—Wild fowl. Classification.
FISH—(general study).	FISH—Common bullhead (life-history).	FISH—Herring (life-history.) Habits of different kinds.	FISH—Structure of fish of common sort.	FISH—Comparison of different kinds of fish.
INSECTS—Caterpillars and butterflies.	INSECTS—Caterpillars and butterflies.	INSECTS—Caterpillars and butterflies.	INSECTS—Caterpillars and moths.	INSECTS—Caterpillars and moths.

TOPICS FOR THE GRADES.

September. October. November.

ANIMALS—*Continued.*

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
INSECTS—Grasshopper.	INSECTS — Grasshopper and cricket. The bee.	INSECTS — Grasshopper, cricket, *beetle.* The house-fly (begin).	INSECTS — Review the foregoing—also spiders, ants, pea-moth (life-history).	INSECTS—The turnip-fly and how to destroy it (life-history). Millipedes.
	THE FROG.	THE FROG.	THE FROG.	THE FROG.

December. January. February.

ANIMALS.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
THE CAT.	THE MOUSE—THE DOG.	THE COW.	THE HORSE.	
BIRDS— A winter bird and its habits.	BIRDS— Same as Part I.	BIRDS— Same as Part I. Study of crow.	BIRDS— Same as Part I.	BIRDS— Same as Part I.

TOPICS FOR THE GRADES.

March. April. May.

ANIMALS.

First Reader, Part I. *First Year.*	First Reader, Part II. *Second Year.*	Second Reader. *Third Year.*	Third Reader. *Fourth Year.*	Fourth Reader. *Fifth Year.*
The Squirrel.	The Cow—(begin the study). Its habits.	The Hare—(begin study). Habits. Cow—Habits, structure, care.	Horse—Habits, structure, care. comparison, uses, family. The Sheep—Life-history.	Horse—Family characteristics. Judging horses. The Pig—Life-history.
Birds— Return of birds; habits, nests, songs. Keep calendar; learn manner. The hen: Study egg and chick.	Birds— Return of birds, habits, nests, songs. Robin—Life-history. The Duck—Study egg, duckling.	Birds— Return of birds, habits, nests, songs. Select bird for life-history Study structure; a little of classification.	Birds— Their return. Two birds unlike (life-history). (Barn swallow typical bird of air, song sparrow typical bird of air). Study relation to environment and to man.	Birds— Their return, etc. Baltimore oriole—Life-history (typical bird of trees). Study especially in relation to environment, in relation to man; classification.
Fish— (general study).	Fish— Continuation of autumn study.	Fish— Continuation of autumn study.	Fish.	Fish.

March. April. May. } TOPICS FOR THE GRADES. { March. April. May.

ANIMALS—*Continued.*

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
INSECTS— Caterpillars and butterflies (cocoons). Milkweed-butterfly.	INSECTS— Caterpillars and butterflies. Cabbage-butterfly.	INSECTS— Caterpillars and butterflies (cocoons). Codling-moth.	INSECTS—Caterpillars and moths. Tent-caterpillar. (A little classification.)	INSECTS— Caterpillars and moths. Classification and reviewing.
INSECTS— The bee.	INSECTS— The house-fly (begin).	INSECTS— The house-fly—(complete). The potato-beetle.	INSECTS— Useful insects especially — Lady-bird, dragon-fly.	INSECTS— Insects injurious to trees — How to destroy them.
	The frog (begin), tadpoles.	The frog—(continued). WORMS— Earthworm.	WORMS— Earthworm (continued). The crayfish.	The crayfish.

June. **ANIMALS.** June.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
Summer yellow bird.	The Young Bird— Special study.	The Young Bird— The meadow lark.	Habits of wild fowl in summer.	

TOPICS FOR THE GRADES.

THE EARTH.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
Pebbles on street and shore.	FORMATION OF SOIL— Pebbles on street and shore. Specimens of sand, gravel, clay, to be found and distinguished.	FORMATION OF SOIL— Collection of different kinds of rocks and fossils.	DIFFERENT KINDS OF SOIL— Collection of rocks and fossils.	Special study of limestone, sandstone, granite.
WATER — Tiny streams on street.	WATER— As power to change banks, break rocks, etc.	Value of ashes, sand, clay, shown as affecting certain kinds of growths.	COAL PRODUCTS— Tar, naphtha, pitch.	LIME— Uses in garden, poultry-yard, lime-water, mortar.
		WATER—Power to penetrate the earth. SPRINGS — Their cause.	Water as a corrosive power upon rocks. Hard and soft. Pure and impure. Test. How to filter water.	WELLS— Good and bad positions. Slope of land. Chalky; clayey or sandy. Depth of well. Its capacity.

TOPICS FOR THE GRADES.

NATURAL PHENOMENA.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
WEATHER — Charts as objective as possible for each month.	Systematic weather-records.	Systematic weather-records.	Systematic weather-records.	Systematic weather-records.
WATER— Different forms. Rain, dew, snow, ice.	WATER — Its different forms. "As affecting the atmosphere."	WATER-FORMS— Special study of clouds, thunder and lightning.	WATER-FORMS— Salt and fresh bodies. Effect on climate.	WATER-FORMS-
WIND—Direction.	WIND—Effect on atmosphere. Those that bring heat, moisture, cold.	WIND— Effect on atmosphere. Causes. Records kept.	WIND — Ventilation: Rules for proper ventilation.	WIND.
LIGHT — Breaking up light; prismatic colors.	LIGHT — The rainbow. The dew-drop.	LIGHT—Effect on plants and animals.	LIGHT.	Effect of heat on solids, liquids, gases.

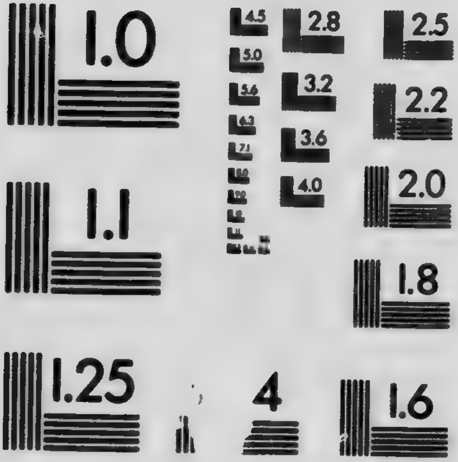
TOPICS FOR THE GRADES.

SUN, MOON, STARS.

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
SUN—Observation of the SUN during the day, especially sunrise and sunset.	Observation of the sun during day—sunrise and sunset. Record time.	Record time of sunrise and sunset.	Record time of sunrise and sunset; altitude.	Variations of altitude.
THE MOON — Position and appearance (when possible).	THE MOON — Position and appearance (when possible).	THE MOON—Make record and drawing during different phases.	THE MOON—Phases, records. General Information.	THE MOON—Phases, records.
THE STARS—General information; very simple talks.	THE STARS—A few interesting, simple talks on general observations made by child.	THE STARS—General Information. Difference between the fixed stars and planets. The North Star.	THE STARS—General Information. The North Star and a few of the constellations: The Great Dipper, Orion, Cassiopeia. Planets visible in early evening.	THE STARS—Recognition of Sirius, Aldebaran, Capella, Vega. Movements of a few stars. Two constellations. Make records.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



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TOPICS FOR THE GRADES.

THE CHILD HIMSELF.

First Reader, Part I. *First Year.*	First Reader, Part II. *Second Year.*	Second Reader. *Third Year.*	Third Reader. *Fourth Year.*	Fourth Reader. *Fifth Year.*
Simple lessons on The Body, structure and different movements.	The Body —Structure; names of some of the parts; movements.	The Body—Structure of different parts.	The Body—Particular study.	The Body—Study from skeleton.
Parts of the Body—Simple lessons (just what child can find out for himself) on teeth, hair, skin, joints.	Parts of the Body—The same. Use emphasized.	Parts of the Body.	Parts of the Body.	Simple lessons on internal vital organs and their care.
Simple lessons on The Senses—Hearing, seeing, feeling, smelling, tasting.	The Senses.	The Senses.	The Senses.	The Senses.
Proper Clothing—Winter and summer.	Proper Clothing—Winter and summer. History of cotton, wool.	Proper Clothing—Winter and summer. History of cotton, wool, silk.	Manufacture of cotton and silk.	Manufacture of different articles of clothing. Select.

TOPICS FOR THE GRADES.

THE CHILD HIMSELF.—*Continued.*

FIRST READER, PART I. *First Year.*	FIRST READER, PART II. *Second Year.*	SECOND READER. *Third Year.*	THIRD READER. *Fourth Year.*	FOURTH READER. *Fifth Year.*
CLEANLINESS (Habits of) — Bathing: how, when. Sleeping: time to go to bed, time to rise. Proper kinds of exercise.	HABITS OF CLEANLINESS — Bathing, sleeping, exercise.	HABITS OF CLEANLINESS.	HABITS OF CLEANLINESS.	HABITS OF CLEANLINESS. Bathing. Sleeping. Exercise.
FOOD—Proper kinds.	FOOD—Proper kinds.	FOOD.	FOOD.	FOOD.
COOKING — Danger of fire.	COOKING— Impress danger of fire. How to make the following: toast, tea, porridge. How to cook an egg.	COOKING— Impress danger of fire. How to boil potatoes. How to fry beef-steak.	How to manage a coal stove, a wood stove. How to boil rice. How to roast and boil meat.	Temperature of oven for different kinds of food. How to make yeast and bread.
	How to set a table for a simple meal.	How to set a dinner table. How to wash dishes.	How to set table for different courses. Care of food left from the table.	How to serve the table properly. Care of different kinds of china, cutlery, glassware, silverware.

TOPICS FOR THE GRADES.

PROCESSES OF FARM AND STREET.

First Reader, Part I. *First Year.*	First Reader, Part II. *Second Year.*	Second Reader. *Third Year.*	Third Reader. *Fourth Year.*	Fourth Reader. *Fifth Year.*
			Eradication of weeds.	Farm Operations—Ploughing, harrowing, reaping, cultivating.
			Rotation of crops. Drainage.	
		Simple lessons on enriching soil.	Manuring (begin).	Manuring.
	Use of simple garden tools—Spade, rake, hoe.	Agricultural instruments.	Agricultural instruments.	Agricultural instruments.

PHENOLOGICAL OBSERVATIONS.

Observations should be made, dates and other points of interest recorded, of such as the following:—Flowering of plants, as hepatica, soft maple, trillium; first ploughing of the season; first sowing of the different kinds of grain; planting potatoes, corn, etc.; last snow to whiten the ground; thunderstorms; first autumn frost; first snow flurry; first snow to whiten the ground; first appearance of birds, insects and wild animals; time of their departure; falling of leaves; flowering of plants throughout the year, etc.

An example is given.

DATE.	WEATHER.	OBSERVATIONS AND REMARKS.
1901. 7th April.	Sunny; a few fleecy clouds; wind west; 58° F. at 10.30 a.m.	A white-throated sparrow in our woods. A blue violet was brought to school by Katie Allan.

The teacher should keep a record-book of classified phenologies. Thus:—

PHENOLOGICAL NOTES ON PLANTS.

DATE.	OBSERVATION.	NAME OF OBSERVER.
1901. 7th April.	A blue violet found in the woods near the Glen Bridge. It is pressed, and will be kept as No. 83.	Katie Allan.

Similarly, there should be a part of the book given up to the phenology of birds, a part to insects, a part to industrial pursuits, etc.

PART III.

CHAPTER I.

BIRDS.

> A light broke in upon my brain—
> It was the carol of a bird:
> It ceased, and then it came again,
> The sweetest song ear ever heard.
>
> —*Byron.*

Again we repeat the only way to study the things in Nature is to live with them. No book can be a perfect guide. No person can fully reveal to you secrets of Nature. Nature alone can do this for you. In no field of Nature is this more nearly true than it is in the bird-world. Nor is there any other kind of study where work brings its reward more surely and more directly than it does here. It opens a whole new world of interest. To have eyes and ears on the alert, as one walks abroad among the delightful sights and sounds of Nature, is to have keenest pleasure. Nor is there any other sound in Nature more attractive to the ear than that of the bird. But one must be trained to hear it, otherwise it mingles with the common sounds and is lost. By such training new interest is given to life, and weariness and care are not unfrequently driven away by the single chirp of a bird. To be trained to hear the sounds of birds is to have a new avenue for enjoyment opened for one.

John Burroughs says: "I suspect it requires a special gift of grace to enable one to hear the bird's song; some new power must be added to the ear, or some obstruction removed. There are not only scales upon our eyes, so that we do not see; there are scales upon our ears so that we do not hear. Bird-songs are not music, properly

speaking, but only suggestions of music. A great many people whose attention would be quickly arrested by the same volume made by a musical, or by any artificial means, never hear them at all. The sound of a boy's penny-whistle there in the grove, or the meadow, would separate itself more from the background of Nature, and be a greater challenge to the ear, than is the strain of the thrush, or the song of the sparrow. There is something elusive, indefinite, neutral about bird-songs that make them strike obliquely, as it were, upon the ear; and we are very apt to miss them. They are a part of Nature, and Nature lies about us, entirely occupied with her own affairs, and quite regardless of our presence. Hence it is with bird-songs as it is with many other things in Nature. They are what we make them. The ear that hears them must be half creative."

"The more I think of it," says Mr. Ruskin, "I find this conclusion more impressed upon me—that the greatest thing a human soul ever does in this world is to *see* something, and tell what it *saw* in a plain way. Hundreds of people can talk for one who can think, but hundreds can think for one who can see. To see clearly is poetry, prophecy and religion—all in one."

But people in general are not only blind, they are also unconscious of their blindness; hence they have no desire to have their eyes opened. No other study tends more directly to make one conscious of imperfect sight, and to create a desire for clear vision, than does the study of birds.

Let a person but once experience that real thrill of joy that comes when he is able to identify a bird, a stranger to him only a short time before, and his interest in bird-life will, in all probability, be established. Such experience, however, is likely to come only to one who has watched the bird again and again under varying conditions, for thus only can he get hold of the characteristic traits which are necessary for its identification. While getting such experience he will, doubtless, feel his power

"to see" gaining in strength. It has been said that the conquest of the eye-beam to the bird-student is as great a triumph as the conquest of the revolver to the hunter.

> The birds around me hopped and played,
> Their thoughts I cannot measure:—
> But the least motion which they made
> It seemed a thrill of pleasure.
>
> —*Wordsworth.*

But to recognize the bird on sight or on hearing; to know its nest and its eggs; the time when it arrives and when it departs, is but a small part of the knowledge necessary to become acquainted with the bird.

To be really acquainted with another person, one certainly should know more about him than to be able to tell his name, where he lives, and when he is at home. One should know something about his likes and his dislikes, his thoughts and his habits; in other words, one should know his personality, and, in a somewhat similar manner, the bird should be known. This kind of knowledge is by far the most important. It is to know the thing itself and not its appearance.

How then shall the teacher lead the child to cultivate such acquaintance with birds?

1. He must be thoroughly in earnest and enthusiastic. Nothing, simply nothing, can be accomplished in this sphere without earnestness and enthusiasm.

2. He must be willing to co-operate with his pupils, and to be led oftentimes by them.

3. He must endeavor always so to act that pupils will feel there is no monopoly of knowledge. New discoveries may be made by the child, or by anyone else, as well as by the teacher.

4. Birds must be watched from time to time, in and about their homes, and their habits strictly noted. This will certainly require patience and perseverance. The teacher must encourage in every possible way the pupils in this outdoor observation. If convenient, take the

whole class on an excursion to the woods. If not convenient to take the whole class, a few pupils may be taken at a time. The child should be encouraged to make observations when he is alone, and as the child will, in all probability, have much more time than the teacher to ramble about, he may see much that the teacher has never seen. He may also ask many reasonable questions the teacher cannot answer. No question should be cast aside simply because it cannot be answered at the time. It is the teacher's business to guide the pupil, if possible, to find an answer to all such questions; and if he will but keep his eyes open this will generally not be a difficult task.

5. In seeking to make the acquaintance of our feathered friends, we must remember that they are very shy. We must learn to approach them gently. It is always best to be quietly dressed—olive brown or dark grey are very suitable. Little girls should not wear bright colors nor hanging ribbons. It is best also to have the hands perfectly free. The least thing strange disturbs or distracts our shy neighbors. If we would see these little friends as they are, we must keep ourselves in the background.

6. Always carry a pencil and a note-book. An opera-glass is also a very great help. You must look very sharply, observe carefully, and report correctly and truthfully, if any progress is to be made. The eye and the mind must be trained to work together. This will come only through repeated effort. The eye always images accurately. The reflex on the retina is always a correct one, but oftentimes when we try to tell what we have seen, there is more or less confusion.

7. Note its general size and shape. Look very carefully at the coloring of the bird above and below. Observe its markings, the color and shape of its beak, its feet and its legs.

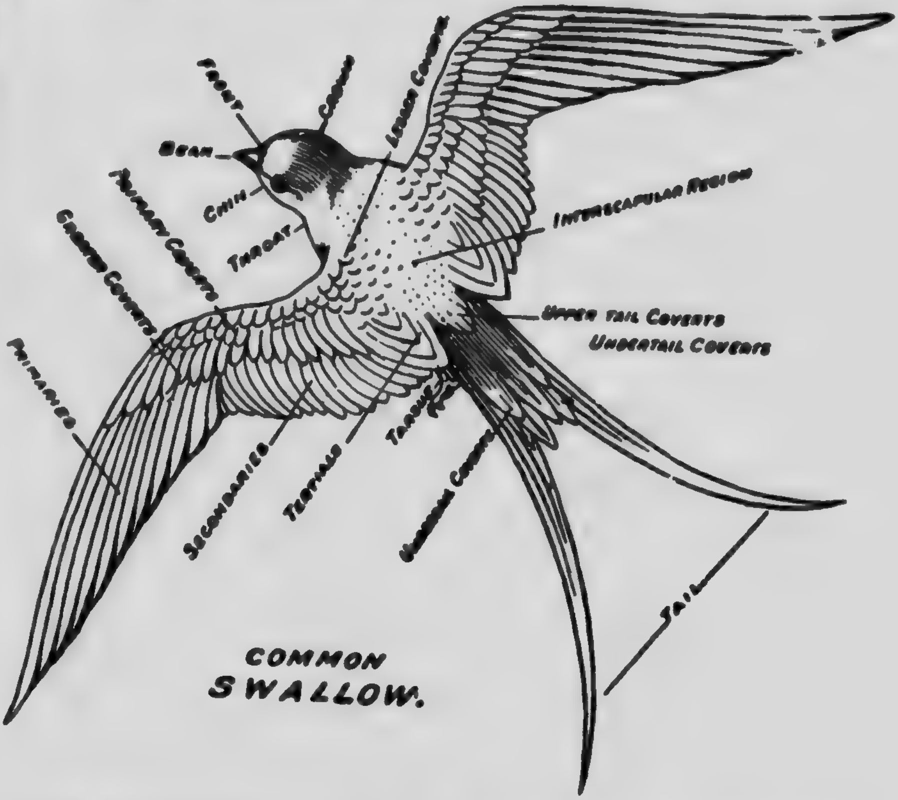
8. Next note its manners—whether it is quiet or restless—whether it jerks its tail or its head—whether it

walks or hops. Follow it keenly as it seeks its food. Note whether it is eating insects or the seeds of grasses and weeds; if insects, observe whether it is picking them from the bark of trees or digging them from the ground or seeking them among flowers and leaves. Then note its call and its song. Jot down, point by point, in your note-book, your thoughts as they are evolved from these observations. Set aside a definite time during school hours for reviewing these notes and identifying the bird; five minutes daily will accomplish a great deal. This will oftentimes give both teacher and pupil trouble. But with the help of a manual, which the teacher should know how to handle, look for descriptions that match those jotted down in the note-book. 1. If the bird hammered on the tree and pecked food from the tree trunk, or limb of the tree, look among woodpeckers; 2. If it flew out, made a turn or two and back to its perch again, look among the flycatchers; 3. If it was eating seeds, look among the finches.

In order to help the child in giving and noting descriptions, draw an outline of a bird on the blackboard. On it mark the names of the different parts. By these means a more accurate and intelligent conversation can be carried on, and a more definite description can be given. If possible mark the nests of certain birds. From time to time visit these nests. Note the eggs, their size, shape, and color—appearance of young bird—how and when it leaves the nest—the mother's care in feeding it—the mother's care in helping it to fly. In this way only can the whole life-history be studied.

There is no bird whose life-history can be so carefully studied as that of the hen. And really, much that is true of the hen is true of every other bird. But to be associated with birds of many kinds, even if we learn little about them, has an effect similar to that of being associated with flowers. We are better and happier for having seen and loved them, even if we do so in merely passing by.

To give definite direction as to the family of the bird on which the teacher should first fix his attention is



COMMON SWALLOW.

almost impossible. Yet he should not be altogether without system or plan. A person who is not interested in birds sees few, if any. A person beginning the study of birds is apt to become bewildered, and consequently lost in confusion, and he will find himself little ahead of the uninterested observer unless he has some definite plan. But, again, suppose the teacher had planned to study the oriole, and observations have led the pupils to become interested in the thrush, generally speaking, it will be wise for the teacher to be led by the pupils, and to be interested, for the time, in what interests them. A time will doubtless come when the teacher can in turn lead the class in his own way. The neighborhood should

help the teacher to decide the question as to the bird or family of birds to be studied.

Select a number of the most common birds of the neighborhood, and in turn study with the child as closely as possible everything that can be learned about them. As the robin and the English sparrow are very common birds, it will be found convenient and helpful to compare other birds with these, especially as to size.

COLOR.—As the color of a bird is nearly always the first thing that strikes the observer, to classify birds according to their color is helpful. The following will serve as a guide:—. Birds conspicuously black or white; 2. Birds black and white; 3. Dusky gray and slate color; 4. Blue and bluish birds; 5. Brown, olive or grayish brown, gray and brown; 6. Green, greenish gray, olive, yellowish olive; 7. Conspicuously yellow and orange; 8. Conspicuously red of any shade.

THE SEASON.—To classify birds according to the time of the year when they are most conspicuous is also helpful. 1. Permanent residents. 2. Winter residents and visitors. 3. Summer residents. 4. Spring and autumn migrants, or rare summer visitors.

It is not necessary to study one or two birds, or even more, to the exclusion of all the others. But group around the types, as far as possible, any birds that may chance to come under observation. Most of the birds that are interesting and within the reach of the child belong to the perchers. There are other types of birds that do interest him. It is very easy, and often very helpful, to teach the child the marked characteristics of the eight great classes of birds. But even this general classification should come naturally. Suppose one child is interested in the robin, another in the duck, another in the wren; each child can readily see that there is something common to the wren and the robin that is not to the duck and the robin. Thus, through striking contrasts, the marked characteristics of the following orders

FIG.5

FIG.6

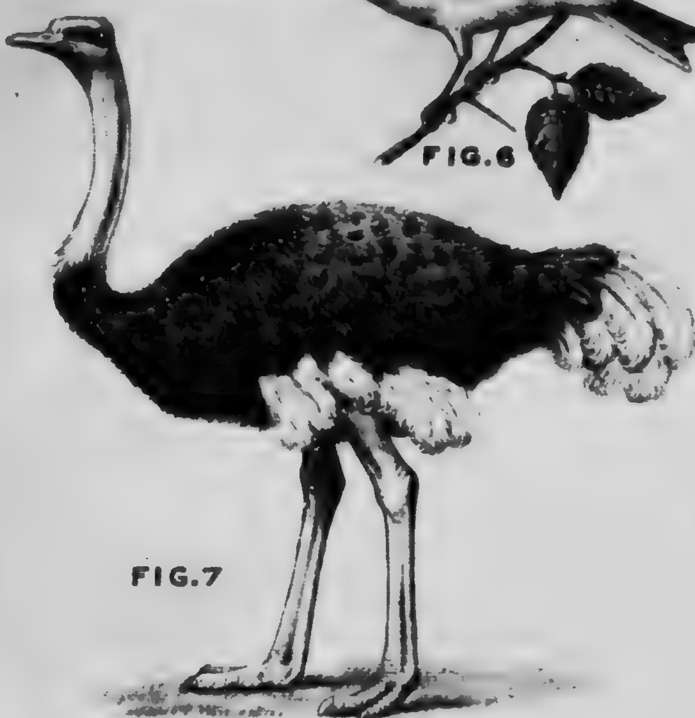


FIG.7

FIG. 8

FIG. 9

FIG. 10

FIG. 11

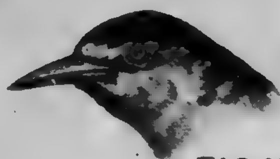


FIG. 12

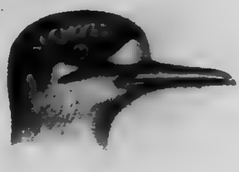


FIG. 13

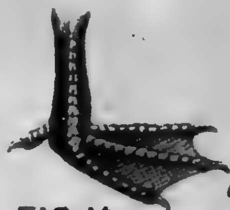


FIG. 14

FIG. 15

FIG. 16

FIG. 17

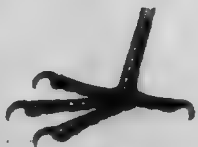


FIG. 18

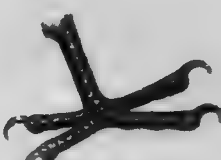


FIG. 19

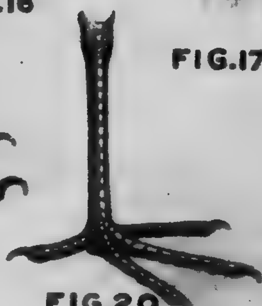


FIG. 20

FIG. 21

can be readily shown:—1. Birds of prey (raptores, Figs. 3, 10, 16); 2. Sparrows, or perchers (passeres, Figs. 6, 12, 18); 3. Climbing birds (scansores, Figs. 4, 11, 19); 4. Doves and pigeons (columbæ); 5. Fowl-like birds, or scratchers (gallinæ, Figs. 2, 9, 15); 6. Running birds (struthiones, Figs. 7, 17, 21); 7. Waders (grallæ, Figs. 5, 13, 20); 8. Web-footed birds, or swimmers (anseres, Figs. 1, 8, 14).

The general characteristics of the above orders of birds might be briefly stated thus:—

1. *Birds of Prey.*—These are strong birds, of considerable size, with closely-knit bodies. The legs and feet are sinewy and strong; the toes have sharp talons. The organs of smell are highly developed. Vision is keen and strong. The upper part of bill is hooked. They have great skill in flying, and live to a great age. Their aspect is fierce. Examples: Hawk, eagle, owl, falcon, vulture.

2. *Perchers.*—The feet of these birds are more slender than those of the birds of prey; they are especially adapted for grasping the branch of a tree. Of the four toes, the first is turned backward, placed on a level with the other toes, has a long claw, and can be perfectly opposed to those in front. The covering of the bill is always hard and horny. These birds are prudent and teachable. Examples: Thrush, swallow, finch, blackbird.

3. *Climbers.*—Two of the toes turn backward; the two others turn forward. The tail feathers are stiff and sharp pointed. The bill is chisel-like. Examples: Woodpecker, cuckoo, parrot.

4. *Doves or Pigeons.*—These birds form the transition to the fowls. They are social, gentle, tame; voice is clucking and cooing. Their flesh is eatable. Examples: Wood-pigeon, passenger-pigeon, crowned-dove.

5. *Scratchers.*—Most of these birds have a crest of bare skin on the head. The males have spurs on the inner side of the tarsus. They have stilt-like legs and

hatch on the ground. Examples: Peacock, pheasa turkey, hen.

6. *Runners.*—The feet of these birds are strong ar muscular; suited for running. The wings are short ar not adapted to flying. Examples: Ostrich, emu.

7. *Waders.*—These birds wade in water and swamp from whence they obtain their food. Some of thes birds are web-footed. Examples: Plover, crane, heror stork, snipe, moor-coot.

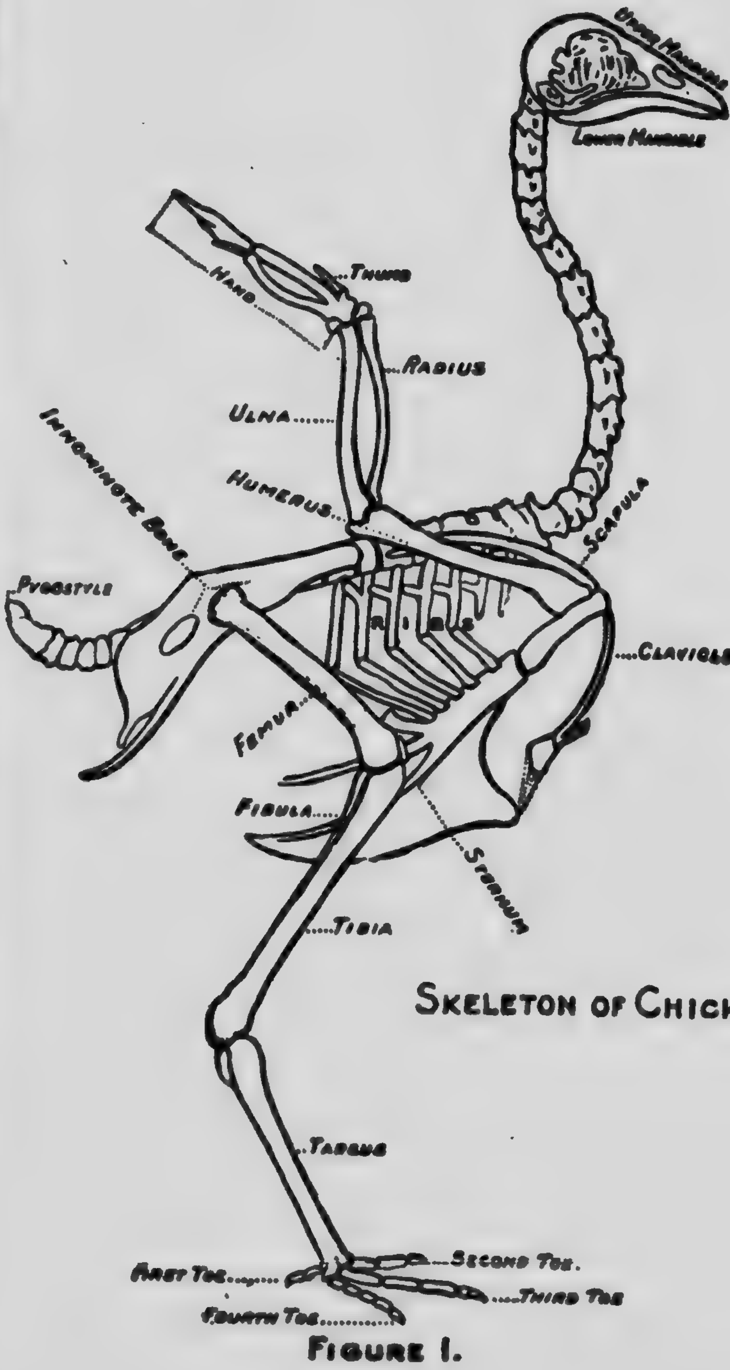
8. *Swimmers.*—The abdomen is boat-shaped; ther is web-membrane connecting the toes; they have clumsy, waddling gait. Examples: Goose, duck, sea gull, swan, pelican.

THE GROUPING OF BIRDS INTO FAMILIES is basec very largely on differences in the bill, feathers of the wing, and the covering of the unfeathered portions of the legs. As the perchers embrace the greatest number of families and those most frequently met by the child, we will note some of the families belonging to this order.

1. *The Thrush Family.*—The members of this family have large, horny, but slightly overlapping plates on the front of the shin (tarsus). They have also *ten* primaries, that is, large feathers attached to the hand or outer segment of the wing. The first or outer primary is always much shorter than the others. Examples: Robin, thrush, bluebird, catbird.

2. *The Swallow Family.*—The members of this family have short, broad, flat, triangular bills, which open widely to a point almost beneath the eyes. The wings are long and strong, with nine primaries. The tail is forked. The feet are small and weak. Examples: Chimney swallow, barn swallow, cliff swallow, sand marten.

3. *The Finch Family.*—The members of this family include all perching birds having cone-shaped beaks and nine primaries. Examples: Rose-breasted grosbeak, goldfinch, song sparrow.



SKELETON OF CHICKEN.

FIGURE 1.

4. *The Blackbird Family.*—The members of thi[s] family have bills markedly longer than the finches. They are also straighter and more slender, with sharpe[r] edges. They are more adapted for cutting than fo[r] crushing. The corners of their mouths have a downward droop. Examples: Bobolink, red-winged blackbird, oriole.

5. *The Flycatchers.*—The members of this family have broad, flat bills. The upper mandible is slightly hooked over the lower. They have a peculiar habit of dashing out suddenly from a post or limb of a tree, catching an insect with a loud snap of the beak, and then returning to the perch to eat it. Examples: Kingbird, phœbebird, wood peewee.

General Structure of Birds in Adaptation to Habits.

(*a*) Firmly united bones of spinal column.

(*b*) Broad breast-bone, with prominent keel for attachment of strong muscles of flight.

(*c*) Long wing, with its strong bones.

(*d*) The ploughshare-shaped bone of the tail.

(*e*) Bones of leg divided into three parts.

(1) Knee-joint bending forward, and near the body.

(2) Ankle bending backward, and some distance from the body.

(3) The shank contains foot-bones in upright position, the joint to which the toes are attached.

(*f*) The projection from each rib overlapping the rib behind it, and serving to protect the organs of the body from injury by the wing stroke.

(*g*) The several large sacks filled with warm air at different places in the body cavity, which tend to lessen the specific gravity of the bird.

(*h*) The high temperature of the blood and the four chambers of the heart, this structure serving to maintain a uniform temperature of the body.

BONES.—Most of the bones of adult birds are hollow and filled with air. Hence, the lightness of the body of birds. For this reason, also, diving birds can remain a long time under water, inasmuch as respiration then is aided by the air in their bones. Bones of animals, on the other hand, are heavy. When not solid they are filled with marrow.

THE COVERING OF BIRDS.

The special mark of a bird is its feathers. All feathered creatures are birds. Feathers, like hair, grow from the skin, and are really made of the same material

as it is made of. Birds' feathers look, at first, like little pimples on the bird's skin. From these little pimples

feathers grow. When the new feather can be seen it is called a pin feather. The feathers of birds are so arranged as to lie smoothly, one overlapping the other. Each has its own proper place. If the feathers get ruffled, it takes great pains to rearrange them. If they get worn or broken, new feathers push up through the skin, and the old ones fall out. Feathers not only serve as a covering for the bird, but the long, strong feathers of the wing and tail assist it in flying.

Let us examine a feather: The middle part is called the shaft. It runs the whole length of the feather. On each side of the shaft we have the web, which is not the same width on both sides. By stretching out the web you can separate it into little pieces; each piece is called a barb. By passing the forward barb—the one near the top of the feather—under the rear one, you can smooth the feather; the barbs will unite again. The rear barb holds fast to the one in front of it by means of hooks. By being thus closely united, the air cannot blow through the feather; the body of the bird is thus kept warm and dry. Then, too, in flying, the bird has to press the air aside much in the same way as the swimmer has to press the water aside; this it could not do if the feather was not formed so as to prevent the air escaping. The concave shape of the feather is also a benefit in flying. Feathers that protect the body have barbs only on the outside part. The part next to the body and concealed by the overlapping feather is soft and downy.

It is the barbs at the tips of the feather that give the color to the bird. For example:—The breast feathers of the robin are bright bay; the part overlapped is dull grey. At times this bright color wears away, and the bird seems to change his appearance without changing his feathers. The tail feathers of such birds as the chimney swift and woodpecker are stiff and spiny; the web extends beyond the tip of the feather. These feathers support the bird when climbing.

FLYING.

The whole structure of a bird is wonderfully adapted for flying. The smallness of the head, feet and viscera; the lightness and strength of the bones; the lightness, elasticity and strength of the wing-structure of the feather; the hollow quill; tapering shaft, are all fitted for making it easy to fly. Then the vane is composed of barbs clinging together by elastic hooks, and one side of the web is wider than the other and overlaps, thus making a flexible and impermeable plane. In the down stroke the feathers by overlapping do not allow the air to pass through, but in the up stroke the air passes through freely. This gives great effectiveness in down stroke, and least possible loss in recovery for the up stroke.

The bird's wing has two distinct functions, viz.:—*That of a propeller* and *that of an aëroplane.* In ordinary flight both of these functions are performed in different relative proportions according to the size of the bird and the extent of its wing. In large birds the wings (except in

rising) act as an aëroplane. In small birds and insects the wings act almost wholly as propellers. In easy flight only the downward stroke is necessary. In making this stroke the wing is slightly tipped and propelled onward. Through the use of the wing as an aëroplane four wonderful feats are performed by the bird—hovering, poising, soaring, sailing.

Hovering.—In hovering the body of the bird is inclined upward and the stroke of the wing is forward as well as downward. The body of the bird is maintained in the air by vigorous flapping.

Poising.—In poising the body of the bird is maintained in the air in a fixed position, the wing being outstretched and motionless. The bird places itself facing the wind, just above the brow of a hill. Its wings and tail (aëroplane) are inclined slightly downward, but not quite so much as the slope of the hill, so that the wind will strike the underside of the wings and tail. In this position the force of gravity tends to carry it downward and forward, while the force of the wind tends to carry it upward and backward. Hence the bird is steadied.

Soaring.—Soaring is an easy, graceful motion. In soaring the bird sweeps about in wide circles with motionless, outstretched wings, not only maintaining its level, but rising in ascending spirals until it disappears from view. The bird always drifts with the wind in spirals inclining to leeward.

Sailing.—With great ease and with very little apparent expenditure of energy, the bird is able to gambol in the fiercest wind. The bird at first skims along almost in contact with the surface of the earth, then wheels about, faces the wind and shoots up in the air oftentimes as high as fifty feet, then turns again with the wind, swoops down a steep incline and again skims the surface. During these movements the wings remain motionless except for an occasional flap, made necessary by a decrease in the strength of the wind.

Migration of Birds.

The happy birds that change their sky
To build and brood; that live their lives
From land to land.

—*Tennyson's "In Memoriam."*

The migration of birds is, even to the keenest observer, still an unsolved mystery. It is now known where each species goes to spend the winter and the summer, the rate of travelling, the time they arrive at their destination, the stopping places on the way, the route by which they travel. But little is known, however, about the marvellous instinct that guides and directs them on their way, that tells them when to leave their southern home, and that directs them where to select a suitable nesting-place. Even in this twentieth century, men stand in wonder—as from time immemorial—and ask "why?"

Language of Birds.

'Tis love creates their melody, and all
This waste of music is the voice of love,
That, even to birds and beasts, the tender arts of pleasing teaches.

—*Thomson's "Seasons."*

Prof. Nelson R. Wood, of the National Museum, at Washington, says:—"Although not a language for continued talking like our own, yet by many and various sounds the birds express a great many different feelings; their calls and cries are always understood by those of their own kind, and frequently by birds of other kinds. Indeed, in cases of danger or need, birds seem at times to speak a common language, so well do they understand each other. Such feelings as *alarm, love, jealousy, contentment, pain* and *pleasure* are expressed each by its own definite sound.

"The *Common Crow* has a vocabulary more expressive and wider in range than that of many of our finest song-birds.

"The *American Wild Turkey* has a vocabulary of at least a dozen words or sounds. This bird is in constant peril from half a dozen sources overhead and under foot; therefore, its different sounds become necessary for its safety. When in danger from overhead, as from a hawk or eagle, it has a low note well drawn out, which warns every member of a flock. When in immediate danger, it has an entirely different note—quick, sharp, tremulous. When danger threatens from a fox or dog, a distinctly different signal is given which signifies 'take wing,' and the turkeys that hear it instantly rise in the air. When feeding in a field where the food is plentiful, the sound is that of contentment until checked by the patriarch of the flock, and then away they go.

"The *Common Hen* is a fine talker, finer than the rooster. Its cackle has three distinct forms, each used for three different purposes. One it uses when seeking a nest or when calling for its mate; one when it is frightened; and one of a very triumphant kind when it flies to and from the nest. The hen has three kinds of songs—the *love* song, a happy response to its mate; the *song of indifference*, when idly hunting for food, and the *lullaby* song, a low, crooning, soothing note hushing the young chickens to sleep."

Kindness of Birds to One Another.

Very many incidents could be told of the kindness of birds to one another. Take note and you will see for yourself. Make a noise like a young bird in distress. Many birds—indeed all who hear it—will come to see what is the matter. Birds have been known to unite in trying to drive cruel robbers from their nest or from their young. They have even tried to hurt their enemy by pecking at his face and eyes. If a robin is in distress and makes itself heard, not only will robins come to see whether they can help it, but catbirds, orioles, chickadees and others will also come. It is not an

uncommon sight in the bird-world to see birds which are unable to take care of themselves, being waited upon with food or helped to a drinking place, by other birds. Such care is generally bestowed upon birds that are blind, lame or otherwise disabled.

Birds are not only kind to one another, but they are also very susceptible to kindness from man. Scatter a few crumbs at the door, or place a cup filled with water on a window; these little comforts will soon be discovered by our sharp-eyed friends, who in turn will become, by way of showing their gratitude, quite tame. These attentions are appreciated most in the winter, when food is scarce and water frozen. If you would be kind to birds never speak to them in an angry tone of voice. So sensitive are they that such tones have been known to frighten them to death.

Our Winter Birds.

Most people associate birds with summer. But many birds of different kinds not only remain in the north during winter, but they seem to take almost as much pleasure out of their life during this stern season as during summer. Indeed, facing the difficulties of winter seems to impart new life and bring fresh joy to them. But where do our little feathered friends live during the cold frosty days and nights? And what is their food? They do not always live, as many suppose, among the thick branches of the evergreen trees. A brush pile left by a woodman often affords the necessary shelter. A mound of sod furnishes a temporary home for the tiny snowbird. The junco frequently takes possession of the forsaken home of a field-mouse; while a hollow tree is the home of such birds as woodpeckers and nuthatches. Blackbirds are often contented with the shelter which dried grasses can give them. The food of winter birds consists chiefly of seeds from weeds and grasses, and berries of the dogwood tree. The partridge lives almost entirely on buds. The following

are among the birds found during the winter:—Grouse, kinglet, chickadee, screech-owl, goldfinch, sparrow, red-shouldered-hawk, crow, bluejay, nuthatch, butcher-bird, purple finch, brown-creeper, downy woodpecker, robin, snowbird, meadow-lark, flicker and song sparrow, with the red-poll, snowflake, red crossbill, cedar bird, snowy owl, and pine-grosbeak.

THE EYE OF THE BIRD.

A bird can see with equal clearness objects near and remote. This is especially true of birds of prey, which also have the power of rapidly changing the eye from a condition of far-sightedness to one of near-sightedness, a change which is very necessary when the bird is swooping upon its prey. The chief peculiarities of structure which give these powers are the following:—

(*a*) Very much convexed cornea, which will bring rays of light from distant objects more quickly to a focus than the less convex cornea of other animals.

(*b*) The eye is elongated, or of a somewhat telescope-like structure, hence rays from very distant objects may be brought to a focus on the retina. This helps us to understand, for instance, how a hawk, soaring in the air, can see a squirrel or mouse at a distance of half a mile.

(*c*) Rapidity of change from far-sightedness to near-sightedness is made possible by the structure of the muscle fibres of the ciliary body. These muscle fibres are of the voluntary type, and not of the involuntary, as is the case in all other forms of animals. By means of these fibres, the bird can control the convexity, of the lens of the eye, changing it rapidly from one degree to another, thus keeping the light constantly focused on the retina.

HOMES OF BIRDS.

O blessed Bird! the earth we pace
Again appears to be
An unsubstantial, faery place
That is fit home for Thee!

—*Wordsworth.*

So closely connected is the life of the bird with its home and its surroundings that the one cannot be studied without equal interest being taken in the other. So many and so varied are the different types of birds that they seem a very part of earth itself, for everywhere they are found, and everywhere their song is that of freedom, and their attitude that of trust.

Away above the world, on the top of some lofty peak of a mountain or giant tree, we find the homes of the eagle and the condor. Little care these birds, with their expansive wing and keen sight, for the world beneath.

Still farther from the haunts of men—on the solitary ocean—and at times, too, when all is tumult instead of calm, we find the frigate-bird, a creature above all ordinary wants, and one which never alights on the water nor seeks land, except to rest and rear its young. Here, also, we meet the albatross, a bird still stronger and more powerful ; the sea-gull, that flies in the face of the wind ; the guillemot, that plunges into the water and seeks its food; and the petrel, that skims its surface.

Another solitary place frequented by birds is the desert. In Nature the thing needed is the thing provided. The desert needs scavengers, and willing workers are found in the vultures.

Along the *river*, *pond* and *lake shore* we find such birds as the kingfisher, the sandpiper, the bank swallow, and other species, each of which has some special attraction peculiar to its home life.

Swampy places afford shelter for still another type of birds. Among such may be mentioned the heron, the swamp sparrow, the marsh-hawk, the wood-duck, the red-winged blackbird, the veery, the coot and the gallinule.

In *bushy pastures* sharp eyes can find many a snug little home. Such surroundings are preferred by the following birds:—The field sparrow, quail, indigo-bird, night-hawk, chestnut-sided warbler, junco and brown thrasher.

The *meadow*, however, is preferred by the bobolink, the meadow-lark, the savanna-sparrow, and the bunting. Again, hosts of birds seem to like the protection that comes from the trees of the *woods*. Among such birds may be mentioned grouse, bluejay, pewee, pine-warbler, black and white creeper, nuthatch, owl, tanager, sharp-shinned sparrow and pigeon-hawks.

Others, again, seem fond of the society of man, for we find them building homes in orchards, along the streets, and near houses and barns. To this class belong the following:—Oriole, downy woodpecker, robin, phœbe, rose-breasted grosbeak, cuckoo, chipping sparrow, king-bird, catbird, yellow warbler, goldfinch, humming-bird, chimney swift, crow, blackbird, house wren, barn swallow, purple finch, house sparrow, bluebird, cowbird, screech-owl.

The nests of birds are of as many different kinds and as varied as are the birds themselves. Some birds content themselves with very simple structures consisting of a few sticks, leaves, or mosses (crow); others, again, are skilful weavers (the oriole). The chickadee digs a hole in a dead stump or tree, and lines it with moss, grass, wool or feathers. The bank swallow digs a tunnel from two to four feet deep; at the end of this he drops a few bits of straw or a few feathers, and is content with such a nest. The kingfisher makes a tunnel three to four feet long and builds a nest similar to that of the bank swallow.

The nest is really the nursery or the home of the young bird before it gets its feathers. A bird spends comparatively little time on its nest before the eggs are laid. After that both male and female assist in incubation. With such a covering as feathers it seldom requires any other protection from the weather.

> Thus, then, to man the voice of Nature spake,
> Go from the creatures thine instruction take,
> Learn from the bird to build.
>
> —*Pope.*

NOTE 1.—Birds' nests may, without cruelty, be collected after the birds have migrated. They make a most interesting collection.

NOTE 2.—Eggs may be modelled in wax. If wax is placed in warm water till it is soft it can be evenly and cleanly worked into any shape. Pulverized chalk mixed with the wax before it hardens will give it a surface like that of eggshell. It also fits it to receive color, for which use oil paints or oil crayons or powdered colors. Varnish when dry with white spirit varnish or copal varnish.

BIRD-DAY.

Ten thousand warblers cheer the day and one
The live-long night; nor those alone whose notes
Nice finger'd art must emulate in vain,
But cawing rooks, and kites that soar sublime
In still repeating circles, screaming loud,
The jay, the pie, and e'en the boding owl
That hails the rising moon, have charms for me.

—*Cowper.*

It is well to have a Friday afternoon set aside for reviewing all the information gathered about birds. The teacher might call this day *bird-day*. Many simple little devices might be resorted to by way of adding charm to this day, so that the children would look forward to it with pleasure. The following are suggested :—Stories about birds; short essays on birds; drawings of birds, charts previously made, put on exhibition (charts of different kinds of feathers are interesting to young children); songs about birds; beautiful gems of literature on birds.

Read the following :—"Wake-Robin," "Birds and Poets," "Locusts and Wild Honey," by John Burroughs.

NOTES ON BIRDS.

THE ROBIN.

Above.—Dull brownish olive-gray.
Head.—Black.
Bill.—Bright yellow.
Feet.—Flesh colored.
Tail.—Brownish black, with exterior feathers; white at inner tip.
Wings.—Dark brownish.
Throat.—Streaked with black and white.
Eyelids.—White.

Breast.—Bright rusty red.

FEMALE.—Duller, with pale breast, resembling male in winter.

Size.—From nine to ten inches.

Nest.—In a tree; frequently an apple-tree; large and rough looking; composed of twigs, grass, and cemented together with mud; lined with fine grass.

Eggs.—From four to five, pale greenish blue.

Manner.—Composed. During excitement nervous jerking of tail over the back; rapid, direct flight; hops lightly over the grass.

NOTE.—The robin dominates birddom with his strong, aggressive personality. Mr. Parkhurst, in his "Bird Calendar," says, "No bird is able to give so many shades of meaning to a single note running through the entire gamut of its possible register." Robins are fond of fruit. A full-grown robin eats as many as sixty-eight earthworms daily. Indeed, some authorities say this number by no means satisfies it. A growing robin will eat over a hundred worms a day. The robin is very fond of the cut-worm; hence is useful to the farmer.

RED-HEADED WOODPECKER.

Head, Neck and Throat.—Crimson.

Breast and Underneath.—White.

Back.—Black and white

Tail.—Blue-black.

Wings.—Broad white bands.

Nest.—In a hole in a tree.

Eggs.—Four to six, and white.

Size.—About as large as a robin.

NOTE.—An expert flycatcher darts out from the limb of a tree at a passing insect; visits orchards during the fruit season; pecks insects from dead bark of tree. Is particularly useful in destroying insects that are injurious to fruit-trees.

BLUEBIRD.

MALE.

Above.—Uniform sky blue.

Below.—Reddish brown.

Belly.—White.

FEMALE.—Duller than male.

Young.—Spotted.

Nest.—In a natural or artificial tree or fence-post, or in boxes.

Eggs.—Four to six pale blue.

NOTE.—A few years ago bluebirds were among our most abundant and familiar birds. They have been driven off by the English sparrow. They come early in spring. The bluebird's song can hardly fail to arrest attention. He sweetly asserts, *tru-al-ly, tru-al-ly.* He shows bravery in defending nests. The young birds are almost black. They come into their splendid heritage of color gradually. Though these birds have a voracious appetite for all sorts of injurious insects, yet they are destructive; they steal both the eggs and young of other birds.

HOUSE WREN.

Above.—Brown; brighter behind.

Below.—Rusty brown or grayish brown, or even grayish white; everywhere waved with a darker shade; seen plainly on wing.

Tail-flanks and Undertail-covers.—Grayish white, with darker shade.

Breast.—Apt to be darker than throat or belly.

Size.—About one-third as large as the bluebird.

Nest.—In a hole or crevice in the neighborhood of a dwelling preferred; composed of twigs, leaves, hair, feathers.

NOTE.—The wren is a sprightly, clever little bird and does much good by destroying insects in trees about orchards and in many out-of-the-way places. It goes into corners where other birds will not go. The wren is very fond of the society of other wrens and man. Its nest is nearly always found near a dwelling. The house sparrow is a great enemy of the wren and often drives it away from its nest.

BARN SWALLOW.

MALE.—Glistening steel blue, shading to black above.

Chin, Breast and Underneath.—Bright chestnut, brown and brilliant buff that glistens in the sunlight.

Tail.—Very deeply forked and slender.

Neck.—Around it a partial collar of steel blue.

FEMALE.—Smaller and paler, with shorter outertail-feathers, making the fork less prominent.

Size.—Half the size of a robin.

Nest.—In barns or other outbuildings, stuck against a beam; composed of pellets of mud and bits of straw and lined with feathers.

Eggs.—Four or five white spotted, with reddish-brown tint.

NOTE.—Great rapidity of flight; graceful aerial evolutions; skims over meadow at a rate more rapid than an express train; then suddenly darts to right or left after insects. Delights in plunge baths. The swallow is the typical bird of the air. It destroys many small-winged insects and ants.

COMMON CROW.

Body.—Glossy black, with violet reflections. Wings appear toothed when spread, and almost equal to the tail in length.

FEMALE.—Less brilliant than the male.

Nest.—In trees, built of sticks and twigs, lined with strips of bark and fine grass.

Eggs.—From four to six, green spotted, and blotched with blackish brown.

Size.—Much larger than the robin. From sixteen to seventeen inches long.

NOTE.—This bird is looked upon as a nuisance. Perhaps, however, if more were known about it, its good deeds would overbalance its bad ones. While it eats eggs, chickens, sprouting corn, fruit and vegetables, it also destroys mice, grubs, caterpillars and grasshoppers. All are acquainted with its familiar cry, *caw-caw-caw.*

SONG SPARROW.

Head.—Brown, striped with three gray bands underneath, gray shading to white, heavily streaked with darkest brown.

Wings.—With dull bay edgings.

Tail.—Much longer than wings; pale brown, with darker shaft linings on the middle feathers.

Size.—Smaller than robin; about the size of English sparrow.

Nest.—On ground or low bush; composed of rootlets, lined with fine grass and occasionally horse-hair.

Eggs.—Variable in marking; grayish, or greenish white, spotted with brown.

NOTE.—The song sparrow seeks the society of man. Found everywhere where human dwellings have been raised within its range. It is at home in our gardens and hedges. Decidedly a bird of good cheer. Not at all retiring, though never bold. A simple, homely sweet melody, heard at all times during the day. Heard also in darkness of midnight and just before dawn. In flying it pumps its tail and acquires more than ordinary sparrow velocity. An all-year-round resident of Ontario. These birds are ravenous insect-eaters. Even the young feed on insects.

WILSON'S THRUSH (VEERY).

Above.—Uniform tawny.

Below.—White.

Sides.—Olive shaded.

Breast and Side of Neck.—Small dusty spot.

Size.—A little smaller than the robin.

Nest.—On or near the ground; composed of leaves and rootlets, rather loosely put together.

Eggs.—Four or five greenish blue.

NOTE.—In Ontario the veery is the most numerous of all the thrushes except the robin. Its song has a sharp, metallic ring. At first it is pleasant, but it afterwards becomes monotonous. As soon as nesting begins the clear, loud *veery* is heard at all hours of the day. It is a tender bird, and is one of the first to leave in the fall. It is a useful little bird. Its principal food is underground grubs. The cut-worm is a special favorite.

CHICKADEE.

Above.—Brownish ash.

Crown, Nape, Chin, and Throat.—Black.

Beneath.—White.

Sides.—Brownish.

Wing and Tail.—Feathers more or less edged with white.

Bill.—Black.

Feet.—Bluish gray.

Size.—A little more than half the size of the robin.

Nest.—A hole appropriated or dug by the bird in a dead tree or stump, not usually very high up, lined with hair-grass, moss, wool, feathers.

Eggs.—Six or eight white, speckled and spotted with reddish brown.

NOTE.—During the breeding season chickadees retire to the woods. At other times they are seen in little bands visiting shade-trees and orchards searching the crevices for insects. The familiar *chick-a-dee-dee-dee* is known to all. The chickadee has also another note—one quite high, which drops suddenly to one much lower, soft and prolonged. This bird is a great favorite. It is noisy, restless, familiar and cheerful. It does good work for farmers and fruit-growers by destroying noxious insects. A single pair of these birds destroy at least five hundred insects daily. It keeps at work winter and summer.

MEADOW-LARK.

MALE.—Upper parts brown, varied with chestnut and deep brown and black; cream-colored streak through centre of crown; dark brown lines running through eye (apparently).

Throat and Chin.—Yellow.

Underneath.—Yellow, shading into buffy brown, spotted and streaked with dark brown.

Outertail-feathers.—White.

Legs.—Long and strong, and claws adapted for walking.

Nest.—On the ground at the foot of a tuft of grass or weeds; lined with dry grass; sometimes partly arched over.

Eggs.—Four to six, white, speckled with reddish brown.

Size.—A good deal larger than the robin.

NOTE.—The meadow-lark is so much like the grasses among which it lives that it is hard to see. The bird is really not a lark. It is a cousin of the blackbird. These birds, if one chances to come upon a flock of them, fly with a whirring sound and a flight something like that of the quail. They have a clear, piercing whistle something like *spring-o'-the-y-e-a-r, spring-o'-the-y-e-a-r.* The bird is usually a resident of Ontario. It sometimes leaves late in October.

This bird destroys insects which work underground, such as cut-worms, wire-worms. It is most valuable.

CHAPTER II.

FLOWERS.

> Your voiceless lips, O flowers, are living preachers,
> Each cup a pulpit, every leaf a book,
> Supplying to my fancy numerous teachers,
> From loneliest nook.
>
> —*Horace Smith.*

If we study carefully how the child treats flowers we shall learn very much about the method that should be adopted in teaching him to know the inner meaning of the flower. Children instinctively love flowers. Beauty is power. Delicacy appeals to the finer senses. Color always attracts; hence the child desires to possess the flower. He tries to do so by plucking it. Make the child feel that the best way to possess a thing is to know all that can be learned about it. Flowers should be the child's daily companions. Encourage the pupils to bring flowers to school. A bunch of flowers on the teacher's desk is a much better monitor than a strap. Flowers have a great many secrets, but they tell their secrets only to those who love them enough to study them. Indeed, some of their secrets, the wisest are not wise enough to understand.

Flower in the crannied wall,
I pluck you out of the crannies;
Hold you here, root and all, in my hand,
Little flower—but if I could understand
What you are, root and all, and all in all,
I should know what God and man is.

—*Tennyson.*

A desire for the real study of flowers can easily be aroused by giving from time to time some general questions which enable the child to discover for himself some of the secrets of the flowers. The following will serve as a guide:

1. Why does the trillium need such a fleshy root?

2. Name some flowers that close at night. Why do they close?

3. What is the use of the down on the stem of certain kinds of thistles?

4. Is the perfume of a flower of any use to the flower itself?

5. Why is the colored part of a flower generally wrapped in a green covering?

By interesting a child in some particular flower and in the particular plant to which it belongs, it is possible to arouse a general interest in plants and thus to fill the child with the spirit which everywhere emanates from them.

Heretofore the child has looked upon the flower as a beautiful thing, as a wonderful thing. The fact must now be emphasized that the most marked beauty of flowers is an adaptation for a definite end, viz., to facilitate fertilization. Their beauty is power. It sheds joy but does not retard work. All talents should be consecrated to life's work. Each part of every plant is fitted for the work it has to do and the place in which it has to work. Its stem is always strong enough to hold leaves and flowers. Leaves are arranged, as in trees, to expose the greatest surface. The color, odor and sweet nectar of the flower *attract insects*, which, in payment for the

food received, carry the pollen from plant to plant, and thus through cross-fertilization the work of seed-making is helped onward. Indeed, flowers and insects are so closely related that they not only work together, but they advance together, as from time to time we find the different parts of each being changed as if to adapt it to the convenience of the other. Then, again, in order that there may be no delay and no inefficient work, certain kinds of insects are attracted to a certain kind of flower; thus we have better work because of *the division* of labor. Seeds while developing are protected in coverings generally of the color of the leaf. All the energy of the plant, assisted by rain, frost, snow and sunshine, is directed towards perfecting the seed.

> Flowers are thoughts that even a child can understand;
> They speak of hope to the fainting heart,
> With a voice of promise they come and part,
> They sleep in dust through the wintry hours,
> They break forth in glory. Bring flowers, bright flowers!
>
> —*Mrs. Hemans.*

The following quotation from Wm. H. Gibson, although not scientifically correct, for plants are not self-conscious beings, yet contains within it much to inspire students of nature, and offers to them a view-point which, although extravagant, is yet infinitely superior to that of the past. The lesson for us is that plants are not dead forms, but rather living organisms with almost infinite powers of adaptations. Every child should be made to feel that there is more in a plant than he sees.

"Let us content ourselves no longer with being mere 'botanists.' . . . . The flowers are not mere comely or curious vegetable creations, with color, odors, petals, stamens and innumerable technical attributes. . . . . The flower is no longer a simple passive victim in the busy bee's sweet pillage, but rather a conscious being, with hopes, aspirations and companionships. The insect is its counterpart. Its fragrance is but a perfumed whisper of welcome, its color is as the wooing blush and rosy lip." —*William Hamilton Gibson.*

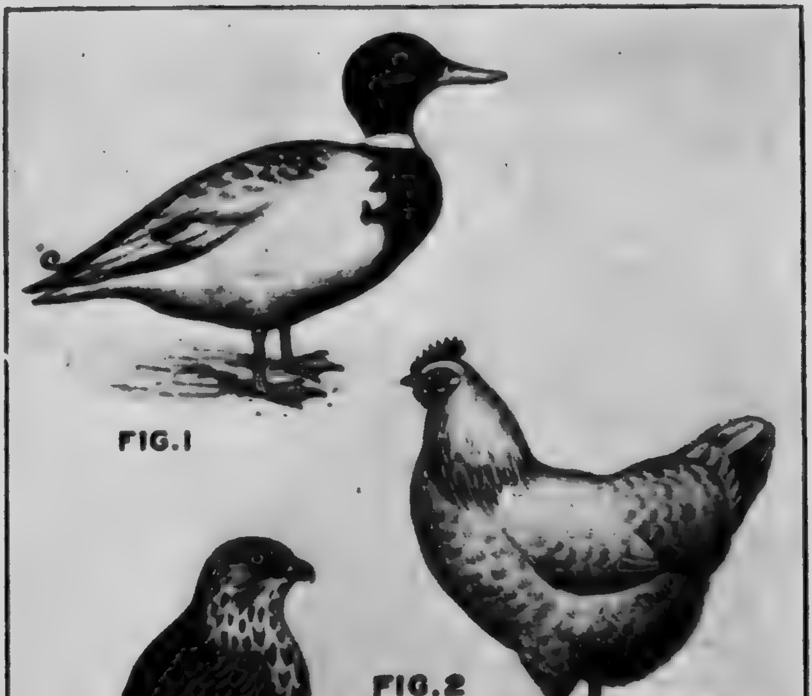


FIG. 1

FIG. 2

FIG. 3

FIG. 4

"I want to know the inner meaning and the understanding of the wild flower of the meadow. I want to know the soul of the flower."—*Richard Jeffries.*

"The most primitive flowers are for the most part simple, widely open, regular, devoid of nectar or nectar easily accessible. Through the agency of insects, flowers are developed from one shape to another. The modified shape is adapted to the body of the insect, the color to his taste, and the time of opening to his habit. The most beautiful perfume and sweet nectar are the outcome of repeated insect selections. Insects carry pollen in a much more economical way than their fellow-worker, the wind. Cross-pollenized blossoms defeat the self-pollenized ones in the struggle for life."—*Neltje Blanchan.*

"The flower passes through white or yellow, and generally red before becoming blue (hence the reason of so few blue flowers). White is the prevailing color of flowers; many of them are perfumed. Color and perfume guide the moth who works at night. Pink is the most unstable color. Magentas incline to purple and pure pink."—*Sir John Lubbock.*

"There is not a single hair without definite design."—*Sprengel.*

Flowers as Symbols.—"In all ages and among almost every people, flowers have been adopted as symbols, types and emblems of human affection and loyalty." The national flower of China is the chrysanthemum. The special flower of the Hindoo has always been the marigold. Among the Romans the lily and the oak were emblems of power; the myrtle and the rose of love; the olive and the violet of learning; the ash of war. Every Canadian knows the meaning of these words—

"The thistle, shamrock, rose entwine
The maple leaf forever."

The emblem of the United States of America has not yet been chosen. The arbutus, corn and golden-rod are rivals for the honor.

Plants.

Each plant has its *own individuality*, its own place to fill, and in this individuality it seems to delight.

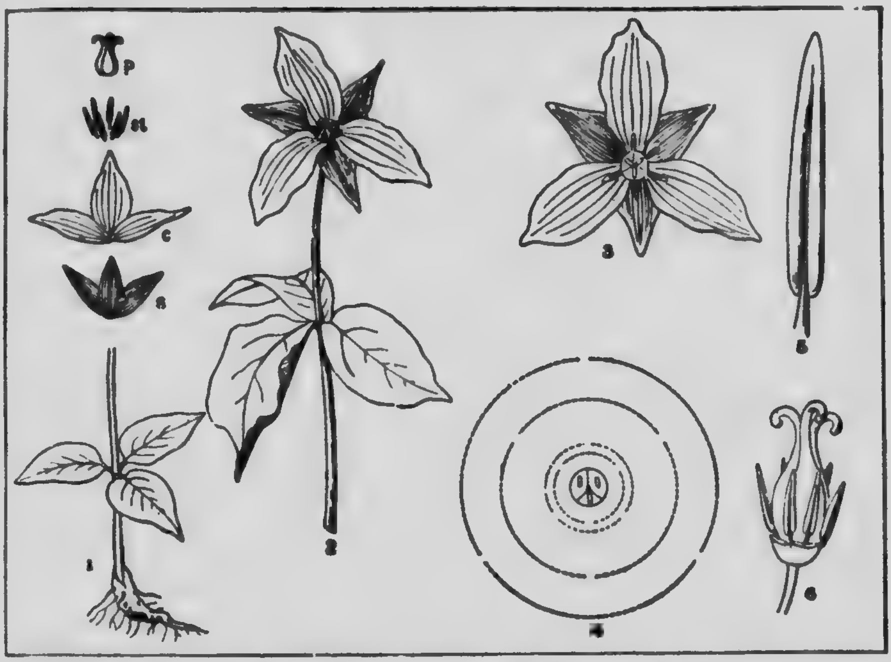
> How doth the little meadow flower its bloom unfold?
> Because the little lovely flower is free
> Down to its root, and in that freedom bold.
> And so the grandeur of the forest tree
> Comes not by casting in a formal mould,
> But from its own divine vitality.
>
> —*Wordsworth.*

Every child in the class should have a plant of his own to watch. The plant should not be bought ready grown, but the child himself should plant the seed or the shoot. This is the surest way to make the child realize that a plant is a living, growing thing—a complete, self-sufficient organism. Almost any plant will serve the purpose. It is, however, well to select one that matures early. The child's enthusiasm may die if kept waiting too long. If there is no room in the school-yard for such plants, they should be planted in pots and kept in the school-room.

In teaching the different parts of the plant and flower, do not hesitate to give the simpler scientific names, when such are necessary to intelligent teaching. Such names should always be associated with the parts of the plant under the observation of the child.

Through the study of a single plant the child will undoubtedly be led to notice the plants of the garden and the field. A little careful guidance at this stage on the part of the teacher will probably open the eyes of the child for the rest of his life to the fact that the plants he sees everywhere around him have put forth their best energies to live—that plants are not distributed in a hap-hazard way without law or order, but they are where they are because they have obeyed law and order. Seeds are scattered by the wind and by the water in every direction, but unless they find the condition necessary for their development they die.

Seeds of different kinds often thrive under similar conditions; hence we often find *different kinds of plants living in colonies.* In such colonies one kind of plant generally predominates. On such waste places, for example, as a common, the flower colonies may be composed chiefly of dandelions or burdocks.



1—Parts of Trillium: (s) Calyx; (c) Corolla; (st) Stamens; (p) Pistil; 2—Trillium 3—Flower; 4—Plan of Flower; 5—Stamen; 6—Stamens and Pistil.

Take the child to visit different colonies of plants, or direct him in such a way that he may make observations for himself.

Aim to show that each plant colony has environments peculiar to itself: thus—(1) In the *dry, open field* we find such plant colonies as the dock and mullen. (2) The *roadside* has such plant colonies as burdock, thistle and rag-weed. (3) The *swamp* has such plant colonies as cat-tails, grasses and buttercups. (4) The *forest* has its overgrowths and its undergrowths. (5) And so different colonies may be noted on the *meadow*, the *river-bank*

and the *hillside;* each of these areas, like those above-mentioned, has its own characteristic plants. (6) After studying plant colonies for a time, the child will begin to *associate* different *plants* with their *environment.* Then too, with a little help, he will soon be able to tell the kind of plants that thrive best in the sun, in the shade, in dry soil or in wet soil. (7) Encourage the child to make a list of the different plants found in each plant colony studied. Note the particular plant that predominates. Dry and mount this for future reference.

The class should study the life-history of some particular plant. Select one that can be found growing in abundance in the neighborhood, so that each child may obtain a specimen frequently. The thistle, the dandelion, the burdock, the milkweed, the violet, are all good subjects.

HEPATICA.

To the lover of flowers the spring holds no greater attraction than "the early wild flowers."

In hopes of finding these treasures the enthusiast will walk miles, conscious only of joyous expectancy, and, should his hopes be realized, so great is his love and admiration for them that he, all too frequently, attributes to them virtues and characteristics that belong alone to human beings.

In the central and eastern provinces of Canada, the delicate little hepatica, the flowers of which vary in color from blue or purple to pink and white, is a general favorite. Its coming is always welcomed with special joy. It is one of the first flowers to make its appearance after the late snows of winter have melted. This accounts, no doubt, in some measure for its welcome. Indeed, as if to defy wind and weather, or as if anxious to be the first harbinger of spring, it is often found pushing its way up through the snow; nor does it wait for the young green leaves to accompany it, but goes to work—seemingly eager to expend its best energy on

its blossom—while the rusty leaves of last year's growth still adhere to it.

The flowers of the hepatica are single, borne at the end of a furry stem or scape. This scape is from four to six inches high, and rises directly from the crown. The calyx is composed of from six to twelve petal-like sepals, and may easily be mistaken for a corolla, as underneath is an involucre of three little green leaves. Each of these flowers generally has numerous stamens and several pistils.

The name "hepatica" is from the Latin "hepaticus, pertaining to the liver," and was given this little flower because of the fancied resemblance of the shape of its three-lobed leaves to the liver. That nature marked it thus in order to indicate its use, which was to cure all cases of liver complaint, was the prevalent belief.

The sharp-lobed hepatica, *hepatica acutiloba*, differs from the above in having the lobes of its leaves pointed. Those of the involucre are also acute.

The hepatica thrives best in light soil, in open woods or on hillsides.

LARGE WHITE TRILLIUM OR WAKE-ROBIN.

Among the finest of the early spring blossoms is the beautiful white trillium. Whether found growing alone or in a clump, side by side, with its companions, or scattered irregularly over the open wood, its delicate beauty cannot fail to attract the eye of the observant. This singular beauty is due in part to the large, pure white petals, and in part to the marked regularity of the plant itself, all the parts of which are in threes; hence the name "trillium." The name "wake-robin" was given this flower because it was supposed to bloom about the time the robins waked into full song after their return from their southern home.

The trillium is a solitary flower. It is borne on an erect or curved peduncle from a whorl of three large,

broadly ovate, green leaves. The three obovate petals of the corolla are so arranged as to alternate with the three narrow, oblong leaves of the calyx. The anthers of each of its six stamens are almost as long as the filaments. The pistil has three spreading stigmas.

The principle that regulates the life of the trillium is unlike that of the hepatica. Instead of dividing its energy by first putting forth its blossom and then its leaves it lays up in its tuberous rootstock a store of nourishment sufficient to supply both leaves and blossom, which appear above ground about the time that the spring sunshine bids them come forth from their winter quarters.

The flower of the trillium is subject to great variation of form and color. Sometimes all the petals are green; at other times they are partly green and partly white. The flower is often double and at times as many as three blossoms are found on the stem.

BLOODROOT.

The bloodroot is the most evanescent of all our early wild flowers. "To blush unseen" is often the fate of this beautiful but fragile blossom, for so fleeting is its beauty that even the most observant has seldom a chance to enjoy its perfect loveliness. A few days of spring sunshine is sufficient to bring it to maturity, and a few gusts of wind is sufficient to cause every petal to tremble and fall.

For this beautiful, short life nature has most carefully planned, and well might the thoughtful ask, "Why does such beauty fade so soon?" Before expanding, we find this blossom carefully wrapped with the leaf of the plant itself in papery bracts. As the leaf pushes its way up through the dark earth, when the spring sunshine bids it come forth, the bud rises on its naked scape above the rounded, deeply-lobed plant-leaf, above its papery wrappings, and expands into full bloom—an exquisite blossom.

with from eight to twelve snow-white petals, twenty-four golden-yellow stamens, and one pistil. The sepals fall as the blossom expands.

The name "bloodroot" is significant. The plant has a thick, red rootstock. It is also charged with a red-orange juice. Wound the plant in any part and this juice will ooze from it freely. As this liquid stains deeply, care should be taken in plucking the flower. The Indians prized this juice most highly. They used it for painting their faces, and also for painting their weapons of war.

Because of its acrid, emetic properties the thick rootstock of the bloodroot is used in medicine to stimulate expectoration.

SPRING-BEAUTY.

The name of this flower must surely be suggestive of beauty of character rather than beauty of form or color, for by comparing it with other wild flowers and then with ideal standards of beauty it cannot be said to rank first among the beautiful flowers of spring as one might infer from the name.

The great charm of the spring-beauty lies, no doubt, in its simple, shrinking modesty. Pluck it and the dainty petals, as if shrinking from the rude touch, close almost at once. A little water and sunshine may revive them and induce them to re-open for a short time, but so sensitive are they that, under any circumstances, if taken from their native home (unless transplanted) they soon droop and die.

To know these pretty blossoms as worthy in any sense of the name "spring-beauty," one must visit them at their home on a day full of bright spring sunshine. On cloudy days and at night they close and remain closed until the sun again shines bright.

The spring-beauty grows in a loose raceme in moist woods and in open groves. Its corolla is pink or rose-

colored with veins of a deeper hue. It has five petal five stamens and one pistil, the style of which is thre cleft at the apex. The calyx is formed of two ovat persistent sepals. The stem is weak; hence often re clines. It is generally from six to ten inches long an rises from a small tuberous root. The leaves of th plant are long and narrow; they are arranged opposit each other.

The name "claytonia," by which this plant is known i some localities, was given it in honor of Dr. John Clayto an American botanist.

COMMON BLUE VIOLET.

Of all the wild flowers the violet is probably the most general favorite Wherever it is found it is beloved. Poets and artists have each in their own way expressed its beauties. Statesmen and warriors have repeatedly chosen it as their emblem, while the sociable and the fashionable worlds have always been charmed by its attractiveness.

The violet is one of the most common of our wild flowers. In certain localities it blooms in great profusion. It prefers low ground, somewhat moist. In color it varies from pale violet blue to deep purple. The deeper and richer shades are to be seen when the violet is found growing in the shade. As the violet grows old its deep shades turn pale, even at times to white. In its size, in the shape of its leaves and sepals this flower also varies. The finer plants, like the richer colors, are to be found in the shade.

The common blue violet is borne on a scape from three to ten inches high. This scape lengthens with age. The corolla has five somewhat unequal petals. The lower one is spurred. This is a kind provision of nature, as it assures cross-fertilization. These spurs serve as a foothold to the insects that visit it in search

of its nectar. They are thus enabled to remain long enough in the best position—head downward; pollen-collecting hairs directly under the anthers—for the body to become loaded with pollen.

The calyx has five sepals extending into ears at the base. The short, broad, golden-yellow stamens are somewhat united around the pistil. The style of the pistil is club-shaped; the stigma is bent. The leaves of the plant are heart-shaped, varying to kidney shape. When young they roll in at the base. The rootstock is thickly dentate.

GOLDEN-ROD.

This attractive flower, conspicuous on many roadsides during August and September, is admired not only because of its rich golden-yellow color, but because of the graceful appearance of its slender wand-like stem.

The species known to botanists as *Solidago Canadensis* is the most common. In the United States there are over eighty native species and when in season whole fields are to be seen in many different parts of the country thickly covered with their beautiful golden blossoms.

In Europe the golden-rod is rare, but it is so much admired that many of the American species are most carefully cultivated.

Solidago Canadensis grows from three to six feet high. The stem is stout, somewhat rough and hairy. The upper part of the stem is branched. Along these branches cluster the small golden-yellow flowerheads. These flowerheads are composed of both ray and disk flowers. The leaves of the plant are lance-shaped, pointed and sharply serrated.

DANDELION.

The dandelion may be considered one of the common gifts that is both useful and beautiful; but like many of

the other common gifts of nature, because so common it is seldom appreciated as it should be.

The dandelion is found throughout the civilized world. It is known to all nations by some equivalent for the name, dandelion (dent de lion, lion's tooth), suggested by the jagged edges of the leaves

Its preferred habitat is grassy fields and lawns, but so great is its vitality and adaptibility that it will grow under the most adverse conditions and in almost any situation. It blooms from early spring till late in the autumn.

The dandelion is looked upon by the gardener as one of his worst enemies. It is one of the so-called weeds that are hard to eradicate. So deep does the thick, firm root penetrate into the soil that it can be pulled up or dug up only by much patient labor. Then, too, by making its way so deep down into the soil, the root is not only protected from extremes of heat and cold, but it is also protected from most of the animals that feed upon roots; hence it is always in a condition ready, at the slightest favorable opportunity, to spring into activity. To attempt to destroy the dandelion by cutting its top off only increases its growth, as several plants spring up instead of one.

The leaves of the plant are pinnately cut, with the lobes pointing backwards. They are deeply and roughly ribbed, and arranged rosette-like around the root of the plant. Thus, they are specially adapted to collect and direct to the root all the moisture that falls upon them, thereby aiding the life of the plant.

The blossom is composed of one hundred and fifty to two hundred perfect ray florets. Possibly each of these tiny florets was once a blossom of five separate petals. They rest on a slightly convex receptacle at the top of a hollow, milky scape. The blossoms close at night, as also by day in rainy weather, in order to preserve the

pollen and save it for insects that aid most in cross-fertilization. Scores o insects visit these flowers, the corolla tubes being filled with sweet nectar. After flowering it bows its head to mature its seed; again it rises on a lengthened scape as if proud of its work. It is now globular, white, airy, set with scores of tiny parachutes, to each of which is attached a tiny seed. These are ready to sail away with the slightest wind. The seeds are not easily killed; they have been known to travel many miles in packing cases with other seeds; they can even float on the water for many days without being destroyed. The roots and flowers of the dandelion are used in making bitters.

COMMON BURDOCK.

The burdock is often thought of as one of the meanest of plants, and yet so beautiful and so perfect is it that it can give, would one but look at it with the seeing eye, thoughts too deep for words.

In the way in which the burdock protects itself against destructive animals, and against other plants competing with it in their struggle for existence, this despised plant shows a thrift and a push, which are well worthy of imitation.

The average height of the stem of the burdock is about three feet; however, it often grows as high as five feet. The leaves, which are whitish underneath, are large and broadly ovate, with edges entire. They contain a bitter, sour juice distasteful to cattle. So the burdock is left to flourish in its favorite habitats—the pasture-field and the barnyard. It blooms from July to October. The flower-head is composed of many tubular florets. They are slightly fragrant, and vary in color from magenta to purple. The involucre is formed of overlapping bracts, tipped with hooked bristles. These hooks attach themselves to whatever comes in their way—even though it

be the tail of a cow. Because of this habit the burdock is more successful in the struggle for existence than many of its more dignified sisters. Then, too, having once found a resting-place, a suitable place to germinate, the seed of this tenacious plant goes to work no matter how far advanced may be the summer.

COMMON THISTLE.

The general observer is apt to pass by the thistle with contempt. It is so often found growing in places reserved for other plants that it is considered simply as a weed fit only to be destroyed. No admiration is given it for the thrift by which it made its way to such a place, nor is the thought of finding beauty in such a despised flower ever entertained. Yet the thistle should be admired—greatly admired—not only for its beauty, but for the principle by which it regulates its life.

The flowerheads of this thistle vary from purple to pale violet. It is solitary at the end of the stem, thickly covered with soft bristles or hairs. Each head is composed of perfect tubular florets. In each of these florets is found a sweet nectar that attracts numerous pollen-carrying insects. Cross-fertilization is due to the work of these insects. The involucre is spherical and covered with many rows of scales which overlap one another. Each scale is tipped with a point or prickle. The hairy or feathery-like appendages (pappus) of the achenes are numerous. The leaves of the plant extend downward and form wings along the stem. They are lobed, prickly above and woolly beneath.

WEEDS.

To me the meanest flower that blows can give
Thoughts that do often lie too deep for tears.

—*Wordsworth.*

In a plant colony each kind of growth is recognized as having equal rights. This is not the case, however, in our gardens and grain fields. The kinds of plants the gardener or farmer expected from the kind of seed sown, are looked upon as the only rightful owners to the soil, and all other kinds of plants are looked upon as usurpers, as weeds. Since the value of a garden or farm depends largely on its freedom from weeds, the study of weeds should, as opportunity presents itself, be a part of every child's training.

MUSTARD—(An annual).

Weeds hinder the growth of the cultivated plants in the following ways: (1) They feed upon the same kind of food as the plant under cultivation and thus they deprive it of its rightful share of nourishment. (2) They absorb so much moisture out of the soil, that they oftentimes rob the surrounding plants to such an extent that these suffer in consequence. (3) Sometimes weeds grow more vigorously than the rightful owners of the soil among which they are found ; hence they choke, crowd or shade these plants. (4) If weeds are allowed to develop in grain fields, their seeds become mixed with the grain, and it is often difficult to separate them. (5) The rusts

that attack grain crops are sometimes nurtured by weeds.

HOUND'S TONGUE—(A biennial weed).

Children—especially in rural schools—should be taught these facts as well as the following things about weeds:

(*a*) Why certain kinds of weeds spread so rapidly.

(*b*) The recognition of the common weeds of the neighborhood and their seeds.

(*c*) How different kinds of weeds propagate themselves.

(*d*) How these different kinds may be best destroyed.

Some weeds—*Annuals*—live for one season only.

Others—*Biennials*—produce leaves and roots the first year and leaves, flowers and seeds the second year; after that, they die.

Others, again—*Perennials*—last from year to year and after they begin, blooming and seeding annually.

These are divided into two classes, viz.:—

1. Those with underground creeping stems, *e.g.*, Canada thistle.

2. Those with roots that do not spread underground, *e.g.*, plantain.

In considering the best means of eradicating weeds, the class to which the weed belongs must be considered

CANADA THISTLE.

first, as the method must depend to a certain extent upon the way in which the plant works. Perhaps the best way for the teacher to deal with this part of the work is to encourage the child to make observations for

himself and to make enquiries from parent and friend. This will not only be beneficial to the child himself,

PLANTAIN (*Plantago lanceolata*), a perennial weed.

but will be one of the best means of uniting home work with school work.

GRASS.

Here I come creeping, creeping everywhere
By the dusty roadside,
On the sunny hillside,
Close by the sunny brook
In every shady nook
I come creeping, creeping, everywhere.

—*Sarah Roberts.*

Grass is frequently spoken of as "the earth's unfailing friend." It grows everywhere—on the rocky height, in the marsh, on the hillsides and in the ravine. In each of these places it stands out in its own useful individuality

to cover that which would otherwise be harsh and bare or to support life as it does on the plains where we find great herds of horses and cattle dependent upon it. Even in the desert this "unfailing friend" springs up to welcome the weary traveller, if only the shadow of a rock shelters it from the rays of the burning sun. The beautiful, it has been said, is as useful as the useful. But grass is not only useful because it is beautiful, but it is useful for many other reasons. It is from the plants of this family that we get a great portion of the food we use. The bread we eat is made from wheat, which is one of the grass family. Our common oats, Indian-corn, barley and rye are grasses. Rice, which forms the chief food of the people of China and the East Indies, is a grass. Sugar-cane, broom-corn and the beautiful bamboos of China are grasses.

SHEEP'S FESCUE. (Roots—perennial, deep, fibrous.)

The Roots of grasses are usually fibrous, that is, formed of bundles of threads. The wisdom of this can be seen. If grasses had a strong central root like a carrot, they could not be so firmly attached to the ground, and hence they could not resist the usage they are apt to receive. These little roots extend downward into the ground to a greater or less depth. The deeper they grow, the better the plants withstand drouth. Sometimes the roots are so numerous, and so much branched, that the soil is bound by them into a matted turf. At other times they creep along beneath the surface and throw up underground shoots, which take root and send up stems.

The Stems of grasses that rise above the ground are usually hollow, and are called culms. These stems are generally cylindrical, as well as hollow. Sometimes, however, as in Canadian blue-grass, they are flattened. The stems of grasses are divided at intervals by thickened solid portions, called nodes or joints. The nodes were at one time supposed to strengthen the stem. It is now, however, thought by some that their only use is to lift up stems that have been beaten or trodden down. Leaves and sometimes branches start from these points. The stems of grasses are divided into three parts. The lower part, which is procumbent and produces roots, is distinguished from the true root by bearing scales, and not only roots, but underground branches, called rootstocks. In the grasses that grow on the ocean beach, these rootstocks help them to hold together and resist the force of the waves. The rootstock is one of the strongest of stems, and the one which most rapidly multiplies the plant. Then we have the stem proper. There is also the upper part, where the spikelet —the flower—is attached. Sometimes the stem has a bulbous formation at the base, which contains a store of food, to be used by the plant when needed. The stem is known as erect, ascending, bending or reclining; leafy, when the sheath encloses it, or naked, when there are no leaves on the upper portion.

KENTUCKY BLUE-GRASS. (Roots—perennial running rootstock.)

Leaves of all grasses consist of two parts, namely, the blade and the sheath. A few tropical species have petioles. The upper part of the leaf is called the blade. It is long and narrow with parallel edges. The lower part which folds around the stem is called the sheath. It usually extends around so far that its edges overlap each other. It matures more quickly than the stem. Its stiffer tissues serve as a protection to the culm in the earlier stages of its growth. The length and breadth of the blade vary considerably. Very narrow blades are described as awl-shaped, and comparatively broader ones are described as sword-shaped. In some instances the apex of the leaf is acute. In others it is tapering or blunt. There is one central rib running down the leaf, called the mid-nerve, or mid-rib, and numerous fine ones running parallel on each side. In corn, for instance, the firmness the mid-rib gives to the leaf can be easily seen. If the mid-rib is not strikingly marked we say the leaf is flat. The surface of the leaf may be smooth, rough, downy, or hairy. The margin is spoken of as plain, downy, hairy, or saw-shaped. Much of the value of grass depends on the quality and quantity of the leaf.

Sedges are closely related to the grass family. They are often mistaken for grasses, but they can be easily distinguished. Beginning with any leaf on the stem of a true grass, one will find the next leaf exactly on the opposite side of the stem and the next directly above the starting point. In sedges, however, the leaves are not so arranged. It is the third leaf from the first that is directly above the first. In the daytime, the leaves stand out from the stem with the upper surface turned upward, and at night they lie quite close to the stem. These sleep movements are due to the influence of light, and are shown in leaves of many other plants.

The Flower.—The small flowers or flower clusters of the grasses are called spikelets. The spikelets together make up what is called the inflorescence. They are arranged in a compact or diffused form. When the flowers

have no pedicels or stalks, they are closely packed together on the axis or stem of the plant. They form a spike. If the flowers are arranged on distinct or nearly equal stalks at intervals on the stem, the cluster is called a raceme. If they are on compound, branching pedicels, they are called panicles.

BARNYARD GRASS. (Roots—annual, fibrous.)

The Spikelet consists of one or more flowers together with three or more scales or bracts, called glumes. The stamens and pistils, as in all other plants, serve for reproduction. In grasses, the anther is attached near its centre to a slender stalk. This enables it to swing to and fro on its slender stalk, and thereby scatter the pollen much more freely. Each little particle of this powder is perfect in itself; it is spherical. The pistil of grasses has from one to three styles, each having a feathery stigma. This stigma is usually curved and waves with the wind in order that it may be able to catch pollen. The ovary in grasses is usually round. The fruit is one-seeded. The embryo, or young plantlet, lies beneath the skin of the seed on the front side at the base.

OBSERVATION ON TREES.

There lives and works
A soul in all things, and that soul is God.
The beauties of the wilderness are His,
That make so gay the solitary place,
Where no eye sees them.

—*Cowper.*

Before beginning the life-history of any tree it is well, as the spring breaks upon us, and as trees appear

clothed anew in their fresh beauty, to take a little time to look around. The sudden change is to all so great, so delightful, so mysterious, that we really require time to get our balance in relation to the new season and the beauties it unfolds to us. Every one, and more particularly the child, likes to go here and there in the spring. Let us meet the child on his own ground, and teach him a little here and a little there, encouraging him to ask questions, and to note what phenomena he can.

Keep the type trees in view. When a child asks a question about any tree that may attract his attention, comparison should be made with the type already studied in its life-history.

General Forms of Trees.

> Thou hast not left thyself without a witness in these shades
> Of thy perfection. Grandeur, strength, and grace,
> Are here to speak of thee. —*Bryant.*

Year after year, the attention of the pupils should be drawn to the forms of the different trees about them. The beauty of form and the differences of appearance can be appreciated only by comparison with other trees and after several seasons of observation. There are almost as great differences in the general forms of trees as there are in any of their other features. The broad, round-topped apple-tree bears a striking contrast to the pointed-shaped Lombardy poplar. The compact top of the maple with its wide base contrasts strikingly with the weeping willow. The straight, upright shape among many evergreens contrasts most markedly with

White Ash.

the cabbage-shaped horse-chestnut. Then we have th ragged and almost shapeless common locust and th spreading beech.

Trunk or Stem.—In **pines, spruces, larches**, the mai stem rises like a great shaft from the ground straigh through the branches to the top. Though these tree have many branches of different shapes, yet the mai stem always remains distinct. In the **oak** the branche are larger in proportion to the main stem; hence th main stem often disappears. In the **elm** the main sten soon merges into its wide-spreading branches.

Branching.—The horizontal branches of many kinds o oaks, the vertical shoots of the Lombardy poplar, the hanging shoots of the weeping willow, and the semi-vertical branches of the maple are all strikingly different.

Twigs.—On some trees the twigs are much more delicate than on other trees. The birch and the elm have slender tips. The ash and the maple are not so delicate, while the tips of the sumach are heavy in comparison. All these differences are very interesting, and should not be passed by unnoticed.


NORWAY SPRUCE—Evergreen Tree

Flowers.—Very few people are sharp enough to notice the blossoms of different trees. The modest blossoms of the pine and spruce are often passed unnoticed. The bloom of most fruit-trees can hardly be unseen. It is striking in its beauty. The blossoms of other trees, however, are perhaps equally as beautiful, though not so striking. The blossom of

the elm has great attractions if closely examined. The bright blossom of the red maple is also beautiful.

Sap.—In spring it is easy to secure sap. Sap is best studied in spring. Draw attention to the following: (1) The watery appearance and the taste of such sap as that of the maple. (2) Milky sap, as that of the sumach. (3) Mucilaginous sap, as that of the pine and the spruce.

Bark.—If opportunity presents itself, or if a ramble can possibly be taken in the woods, select first for this study barks that show a marked contrast. It is not at all inconvenient to obtain samples of the different kinds of bark. These could be taken into the schoolroom, but bark shows its characteristics better when seen on trees. Contrast the clinging dark-colored ash, with its netted gashing, with the regular peeling and almost snow-white bark of the paper birch. Contrast the thick, deeply-gashed and dark-colored bark of many willows with the thin, smooth and light-colored bark of the beech. Then we have the shaggy, light-colored shell bark of the hickory and the close-clinging bark of the beech or balsam fir. In studying the life-history of the tree the different layers of bark and its formation from year to year will, of course, be carefully noted.

WEEPING BIRCH.

Wood.—Encourage pupils to bring pieces of different kinds of wood. Have them cut so as to show the grain of the wood. Show the pupil how this is done. Put some of the pieces in the cabinet. Experiment with others. Examine hardwoods—oak, hickory. Examine the soft woods—basswood, willow, pine. Note (1) the difference in graining of the maple, the pine and the

oak. (2) The distinct layers of the ash and the che nut. (3) The even grains of the beech. (4) The spots the bird's-eye maple.

Color.—Woods have a variety of color, for examp the white pine, the red cherry and red cedar, the da walnut, the white maple, the yellow oak. Some woo take a much higher polish than do others.

For general reference the teacher would do well keep the following before him :—

General Appearance.—Form, size, comparison wi other trees.

Roots.—Size, kind.

Branches.—Horizontal, vertical, slanting, drooping.

Twigs.—Slender, strong, curved.

Bark.—Thickness, roughness, looseness, color.

Sap.—Watery, milky, mucilaginous.

Buds.—Position, number, covering, size, form, contents

Leaves.—Parts, arrangement, kinds, color, size, thick ness, surface, form, veining, edges, duration.

Flower.—Position, color, shape, size, odor.

Fruit.—Form, size, color, usefulness, kind.

Wood.—Hardness, color, grain, durability, weight.

TREES OF THE FOREST.

Hurrah ! for the beautiful tree.
Hurrah ! for the forest grand.
The pride of His centuries.
The garden of God's own land.

—*W. H. Venable.*

Little is ever accomplished in any line without definite plans. The study of trees is no exception. Every teacher interested in Nature-study should keep before him a list of trees for special study. Select first the trees that the child will be most likely to meet with every day. In time add to this list. Keep a note-book.

Every time anything new is learned about the tree, jot it down ; compare these observations with those of a good text-book. The following list will perhaps be helpful to teachers of the first three grades in making a selection :

HARD MAPLE. ROCK MAPLE. SUGAR MAPLE.

Of all the trees of our forests the sugar maple is in many respects the most noble, the most majestic. It is also one of the most useful. When found growing in the open with its branches exposed on all sides to the light, its beauty and symmetry can scarcely fail to arrest attention. It is then a dense mass of beautiful deep-green foliage, generally round-topped and broad-based. Sometimes, however, it is pyramidal in form. The average height of this tree is from fifty to sixty feet. Under very favorable conditions it sometimes reaches seventy feet. The bark is light grey, rather smooth when the tree is young, but getting rough and scaly as the tree grows old.

As an ornamental tree the sugar maple has no equal, for besides its perfect shape and rich verdure it is attractive on account of the cleanliness of its foliage. Of all our deciduous trees it is the least subject to attacks of insects. It is also hardy and can be easily transplanted.

The favorite habitat of this tree is steep and shady banks of rivers. It thrives best in deep, rich soil that is not too moist.

It blooms as early as April or May. The flowers, which appear with the leaves, are pale greenish yellow, borne in clusters and suspended by slender, drooping peduncles.

The seed is contained in two capsules, winged and united at the base. To all appearance each of the keys is perfect, but on close examination one of them will always be found empty. They ripen in October.

The fruit of this tree usually matures once in two or three years.

The leaves are unequally divided into from five seven sharply-pointed lobes. They are opposite eac other on the twig and attached to it by long petiol The upper side of the leaf is smooth (glabrous), and a bright-green color; the under side is somewhat light and covered with fine hairs (pubescent), especially alo the ribs.

In autumn the colors of these leaves change to thos of the purest and clearest red, yellow and orange, wit many different shades and tints thereof.

The wood of this tree when newly cut is white, bu when exposed to the light it becomes red. The grai is fine and close and takes a high polish. It frequentl shows accidental forms in the arrangement of its fibres One of these forms is the curled maple, the rays o which are undulatory. Another form is the bird's-ey maple, so named because of the small whitish spots occurring about every tenth of an inch apart in the wood. Both these forms are valued most highly by the cabinet-maker. But besides being used in the manufacture of furniture the wood is used for many other purposes. A few which might be mentioned are the following: Frames for houses; foundation pieces for mills and canals; runners for sleighs; spokes and axletrees for carriages; firewood.

This tree is also valuable because of the saccharine qualities of its sap. A single tree is able to produce from two to four pounds of sugar annually.

RED MAPLE. SOFT MAPLE.

This tree resembles the sugar maple in its general form and appearance and in the shape of its leaves. During early spring and in the autumn, however, it is a much more beautiful tree. This additional beauty is due in spring to its exquisite crimson blossoms, and in autumn to the brilliant tints and shades of its leaves, which are more striking than those of any other tree.

In April, and often before the snow is entirely off the ground, these beautiful, showy blossoms burst forth as if to announce the return of spring. They grow on short pedicels, in drooping, umbel-like clusters, and are always in advance of the leaves.

The growth of the soft maple is much more rapid than that of the hard maple. Because of this fact it is more frequently planted as a shade-tree than the hard maple, although it is not considered so fine when full grown.

The growth of this tree has a wider range than the sugar maple. It is found both farther north and farther south. Its preferred habitat is low, rich, moist soil.

The fruit of this tree closely resembles that of the hard maple. Its wings, however, are farther apart and it is also somewhat smaller. The seeds begin to germinate as soon as they fall.

AMERICAN BEECH.

This is one of the most important and one of the most widely distributed of our forest trees. Its beauty though of a different type from that of the maple is equally marked.

This tree is compact in shape, rounded at the top. In midsummer the foliage lies in great shelving masses. This effect is due to the horizontal arrangement of its branches. The real beauty of the tree, however, is seen in the winter. Then its bluish-grey bark, by exposure to the weather, becomes bright and beautiful. Its strong, smooth stem, which frequently rises as high as sixty feet, is visible to the top, while the structure of its massive head and its delicate branches are also plainly visible and at times striking in their uniformity.

The beech blossoms in April or May according to the weather and locality and when the leaves are about one-third grown. Both staminate and pistillate flowers are produced by the same tree. The staminate flowers

are clustered on drooping peduncles. They are yellowish in color. The pistillate flowers are borne from the axil of the leaf in two-flowered clusters only.

The leaves of the beech are alternate, rounded at the base and pointed at the apex. They are feather-veined and coarsely serrate.

The fruit is a burr covered with prickles. This burr, which opens with the first frost, contains a triangular-shaped nut of a pale chestnut-brown color.

The wood is strong, hard and tough. It is light red, straight-grained and takes a high polish. It is used in the manufacture of chairs, agricultural implements and handles of tools.

WHITE OAK.

The oak has always been considered an emblem of grandeur, strength and duration. The ancients not only loved and reverenced this tree, but they also attributed to it oracular powers. The venerable age to which it lives may, in part, have accounted for this. Records have been found that show the age of many of these trees to be over a thousand years.

The white oak is one of the most majestic of all the species of the oaks. Its height ranges from sixty to eighty feet. Its preferred habitat is rich woods.

The leaves of this species are simple, alternate with from three to nine broad, rounded lobes. The edges of these lobes are entire. The sinuses are rounded and narrow. In autumn the leaves take on a ruddy hue. They cling to the tree till the beginning of winter.

The acorns are axillary. They grow in pairs on short peduncles. The cup of the acorn is of a woody texture made up of small scales grown together. The oblong nut, which is green at the beginning of the season, turns a rich chestnut-brown when ripe. It is then sweet and edible, and from three-quarters of an inch to an inch long.

The wood is used in ship-building, in the manufacture of furniture, and for wainscot. The bark is used in tanning.

AMERICAN ELM.

The elm when found growing in the open is truly a tree of great dignity and grandeur. Its typical form bears a marked contrast to that of the maple, the beech, or the ash. At about one-third of its height it divides into three or more branches. These branches diverge outward and upward, dividing and sub-dividing on all sides into numerous smaller branches, from which hang the most graceful and flexible branchlets. So long and flexible are these branches that at times they touch or nearly touch the ground, thus forming a most inviting arch. As a shade-tree, or as an ornamental tree on the lawn, the elm cannot be surpassed. Its growth, too, is rapid.

The elm is one of the first trees to blossom in the spring. Its flowers are diœcious. They hang on slender pedicels in close, drooping clusters of from eight to twenty, and appear before the leaves. The fruit is an oval samara winged all round.

The leaves are oval, irregular at the base, pointed at the apex. They are deeply denticulated and have prominent ribs.

The wood of the elm is coarsely grained, hard, strong and tough. It is used for ship-building, for flooring and in the manufacture of waggons, barrels and fruit-baskets.

WHITE ASH.

The ashes are a most interesting group of trees. Of this group the white ash is, especially when young, one of the most beautiful of the species. It is then a most graceful tree. Its stem, which is comparatively slender, frequently runs as high as eighty feet. When it attains little more than half its full height it divides. A central

shaft, however, is retained. From this shaft the branches diverge in graceful curves. As they proceed upwards they grow shorter and shorter until they reach the top. The effect of this upon the shape of the tree is to give it a somewhat rounded top, a broad base, with lower branches drooping much more than those higher up on the tree.

The white ash, so named because of the color of its wood, will thrive only in a rich, moist, deep soil. It is valuable not only as an ornamental tree, but as a commercial product, the wood being used for any purpose where toughness and durability are required. It bears transplanting well.

This tree blooms in May before its leaves appear. The flowers are diœcious, light green, and borne in lengthened panicles near the end of the branch. They are succeeded by keys about an inch and a half in length, which hang in loose clusters from slender pedicels. The wings of these keys are lance-shaped. The leaves are opposite each other, pinnately compound, and from eight to twelve inches long. The leaflets are rounded at the base and pointed at the apex. They number from five to nine and are from three to five inches long.

The buds are characteristic. They are large and broad, of a pale brown color and intensely bitter. The terminal bud is much larger than the lateral buds.

CANOE BIRCH. PAPER BIRCH.

This is one of the two trees, the aspen being the other, that is found from the east to the west of Canada. In the West, however, it never becomes as fine a tree as it does in the East.

The bark of this tree is its most striking characteristic. It is smooth, white, tough and durable. It will peel readily from the tree, and can be easily separated into papery sheets, which are of a light red tint, marked with short, dark lines.

The leaves are simple, alternate, serrate, rounded at the base and pointed at the apex.

The flowers are imperfect and grow in scaly catkins on slender stalks. The tiny nuts have rather broad wings, frequently fringed.

This tree is associated with the Indians of America. Their canoes were made out of the bark, which is light, tough and durable. They also made a kind of syrup out of the sap of the tree. In later years the white man followed the Indian's example, and used the tree for the same purpose.

WHITE PINE.

The white pine is the tallest and most stately of the cone-bearing trees. Its height ranges from eighty to one hundred and seventy-five feet. In the forest the stem usually grows as straight as an arrow. It is bare. The branches, until the tree nears its top, fall off. On reaching the top, however, they develop, spread out and form a shapely head.

In the open this is a rather graceful tree. The horizontal branches, which are in whorls, remain on the tree and lengthen. This formal regularity and the deep, rich green of its delicate foliage is most effective and gives the tree a marked individuality.

The three-sided, needle-shaped leaves are from three to five inches long. They are arranged along the branches in clusters of five. Each cluster has a short sheath.

The cones are narrow, cylindrical, slightly curved and from four to six inches long. Their scales are thin and blunt.

The white pine is one of our most valuable timber trees. Its wood is light, soft, free from knots, and of a light yellowish color. It takes a high polish. It is used chiefly in cabinet-making, for carpentry and for the masts and spars of vessels.

RED PINE. CANADIAN PINE.

The red pine is a most striking and picturesque tre
It is quite different in appearance from the white pin

Its bark is of a clear, bright, reddish-brown colo
whereas that of the white pine is greenish grey.

Its needle-shaped leaves are also much coarser. The
are also longer, ranging in length from five to eigh
inches. Then, too, they are arranged in clusters of tw
along the branches, and in thick, soft tufts at the end o
the branches.

The cones also are much shorter than those of th
white pine. Their arrangement on the branch is unlik
that of the white pine. Those of the red pine grow in
clusters at the end of the branches.

The wood of the red pine is heavy, strong and durable.
It is preferable for some uses, such as construction of
bridges, to that of the white pine.

This tree flourishes in central and eastern Canada.
Its timber is largely exported to Great Britain.

SCRUB PINE. GREY PINE.

This is one of the principal trees of the sub-arctic forest of western Canada. Speaking of this tree Prof. Macoun says, "Wherever the ground is sandy or rocky, or both, the Banksian pine flourishes, and as it passes from east to west it loses its low and scrubby character, as is the case along the St. Lawrence and Lake Superior, though it is a much finer tree in the latter district, and becomes a handsome tree west of Lake Winnipeg."

The leaves of the scrub pine are in clusters of two, with a sheath. They are an inch long and grow thickly along the branches.

The cones usually grow in pairs and curve slightly in the direction of the branches. The scales are thick and tipped with a spine.

The wood as a timber is not valuable. Its chief use is for fuel and for making charcoal.

BLACK SPRUCE.

The black spruce grows abundantly in central and eastern Canada. It thrives best in moist soil, in swamps and in cold mountain woods. Hence we find it flourishing in the Maritime provinces in place of the original hardwood forests of maple, birch, and ash, that once clothed the soil. The sea air is uncongenial to these trees—the birch excepted—and a new race of cone-bearing trees, the spruce, fir and tamarack, has sprung up in their stead. The best specimens of the tree are found in Prince Edward Island.

In the sub-arctic forests of the West, the habitat of the black spruce changes. "As it approaches its northern limit," states Professor Macoun, "it, too, seems to enjoy the drier ground, and vies with the white spruce in occupying the last oases before the forest ceases altogether."

In wilds congenial to it, this tree grows better than it does under the most skilful culture. When found growing in a dense forest or thicket, the tall, slender stem is branchless until it reaches the open. On lawns or in places where the tree has plenty of room to develop itself on all sides, it is clothed in branches almost to the ground. As age approaches, however, these lower branches become ragged and unsightly.

The needle-shaped leaves grow thickly on all sides of the branch. Their color is dark blue-green. When in mass, they appear almost black; hence the name "black spruce."

The ovoid cones are from one-half to one and a half inches long. They are clustered close to the stem and branches. When young they are purple, but turn to reddish brown as they mature. Most of them cling to the tree for a very long time.

The wood of this tree makes excellent timber. It is used for masts and spars of vessels. For making pulp, it is one of the most valuable of woods; its texture is soft and fibrous. Beer is made from its branches. Gum is made from its resin.

WHITE SPRUCE.

The white spruce is a much more beautiful tree than the black spruce. It is more like the balsam fir. Both its bark and its foliage are also lighter in color, while its cones are, at the tips of the branches, drooping and deciduous Then, too, they are longer, their usual length being from an inch to two inches, and their scales are thinner and more papery.

The wood, when polished, is satin-like, clear and white. It is used for fine interior finishing.

HEMLOCK.

A very beautiful tree, being one of the most graceful of trees. The branches are slender and pliant. They hang gracefully, drooping; the lower touch the ground.

The foliage is heavy, arranged on both sides of the branch. The leaves are flat, dark, lustrous, green above, white underneath.

The cones are small—about half an inch long. They are solitary and drooping at the ends of the branchlets.

The wood is not very valuable. If exposed to the weather, it has neither strength nor durability. It is much used for the studding of houses. The bark is used in tanning.

BALSAM OR BALM OF GILEAD FIR.

This resembles the spruce, a beautiful tree when young —a slender, pyramid of dark green foliage that tapers rapidly from the base up. In the forest, the oldest limbs die. In the open, as the tree ages, they become pendulous, sweeping the ground. Its preferred habitat is cold, damp woods or swamps. It blooms in April or May.

The leaves are flat, needle-shaped, blunt at the apex, shining, green above and silvery underneath, arranged around the branch, but appear two-ranked because of a twist near the base.

The cones are violet, from two to four inches long. They sit erect on the upper side of the branch.

Because of their elasticity the boughs of this tree make good beds for the hunter. Pillows are made from the leaves when dried. They have an aromatic odor. The gum is used in medicine. It is sold under the name of Canada balsam. The wood is used as cheap lumber.

AMERICAN OR BLACK LARCH. TAMARACK.

The tamarack is a singularly beautiful and graceful tree. In general outline, it is pyramidal. Its stem, which is perfectly straight, frequently grows to the height of ninety feet. Its preferred habitat is cold, deep swamps.

In Nova Scotia and in New Brunswick the cutting away of the forests has let in the sea air. This has caused such a change in the climate that the tamarack flourishes in places once possessed by the hardwood trees of the original forest.

This tree blooms in May before the leaves appear. The pistillate flowers are red. The staminate ones are yellow.

The leaves, which are needle-shaped and about half an inch long, grow in bunches on short twigs along the branches. They are light green, soft and delicate, and fall in the autumn. The cones are from one-half to three-quarters of an inch long. They grow on short peduncles at the ends of the branches. When young, they are green; but, on reaching maturity, they become brown.

The long, tough, stringy roots of this tree, as found growing in the swamp, are characteristic.

The wood is strong and durable. As a timber it is valuable.

ARBOR VITÆ. WHITE CEDAR.

This tree grows best in swamps, on rocky banks of streams, or on the borders of rivers, ponds, etc. It grows from fifty to sixty feet high. Its foliage is so dense, and it stands the knife so well, that it is used as hedges.

It forms a closer leafy screen than any of the other evergreens.

The leaves are arranged in four rows, in alternate, opposite pairs, forming a fan-like branchlet. They are scale-like. When bruised they exhale an agreeable aromatic odor. The name "arbor vitæ," tree of life, is supposed to have been given it because the bark and twigs of the tree yield a pungent, aromatic oil valuable in medicinal preparations.

The wood has an agreeable odor. It has been used in sacrificial offerings; hence the scientific name *Thuja occidentalis—thuja*, from the Greek, signifying to sacrifice. This tree and *Cupressus thyoides* are both popularly known as white cedar. Because of this considerable confusion arises.

The cones ripen in the beginning of the season; they are pale cinnamon brown, one-third to one-half inch long. The seeds are broadly winged all round. The wood is used as railway ties, shingles, fence-posts.

RED CEDAR. SAVIN.

This tree, Juniperus Virginiana of the botanists, has wonderful power to adapt itself to various conditions of soil and climate. It ranges in size from a low bush to a fine, large tree, sixty to ninety feet high.

In eastern Canada it grows on the rocky banks of streams or on shallow soil on limestone. In the western part of Canada its favorite habitat is peat-bogs or by the lake shore.

Although so distinct in habit, consequently distinct in appearance, there is no clear character by which it may be separated into two species.

The tree blooms in April or May. The minute olive-green leaves are scale-shaped. They overlap each other and grow in four rows on the fine branchlets.

The fruit is a small bluish-grey berry. It grows erect and close to the branchlets. The bark is reddish brown. It can be easily separated into shreds.

The wood is used for posts, rails and rustic work. Its chief use, however, is in the manufacture of lead pencils.

THE COMMON JUNIPER OR GROUND CEDAR.

This tree is considered by some to be the most widely distributed tree in the Northern hemisphere. It is a native of both the Old and New Worlds. Compared with the junipers of the Old World, the American variety is simply a straggling shrub.

The European variety is frequently cultivated in this country. Under favorable conditions, it grows as high as twenty feet.

This tree may be readily recognized among the evergreens by its awl-shaped leaves, arranged in whorls of three up and down its slender branchlets.

The long bluish-grey berries are sessile, glaucous and fragrant when dried. They are used in medicine and as a flavoring for gin.

SEEDS.

Prior to the study of germination, there should be a lesson on seeds for the purpose of noting the parts. The functions of these parts will not be given the pupils, but will be for investigation during the progress of germination in the seeds planted at home and in the school or window garden. The intensity of the study on the seed will depend on the status of the class. The following is a fairly complete outline :—

I. Parts of Seeds.

1. *Covering or Coats.*—The outer coat is called the testa ; the inner coat when present is called the tegmen.

2. *The Seed-leaves.*—There may be but one, as in the corn, or two, as in the bean and pea, or more than two, as in the pine. These are the cotyledons.

3. A small stem-like appendage connected with the cotyledon or cotyledons, and consisting of two parts, (*a*) the *plumule*, a small bud which develops into the aerial parts of the plant, and (*b*) the *caulicle*, from which is developed the root.

4. In some seeds there is found in addition to th[e] above parts a store of albumen outside of the cotyledons as in the corn, the castor bean and the buttercup.

II. Markings on Coat.

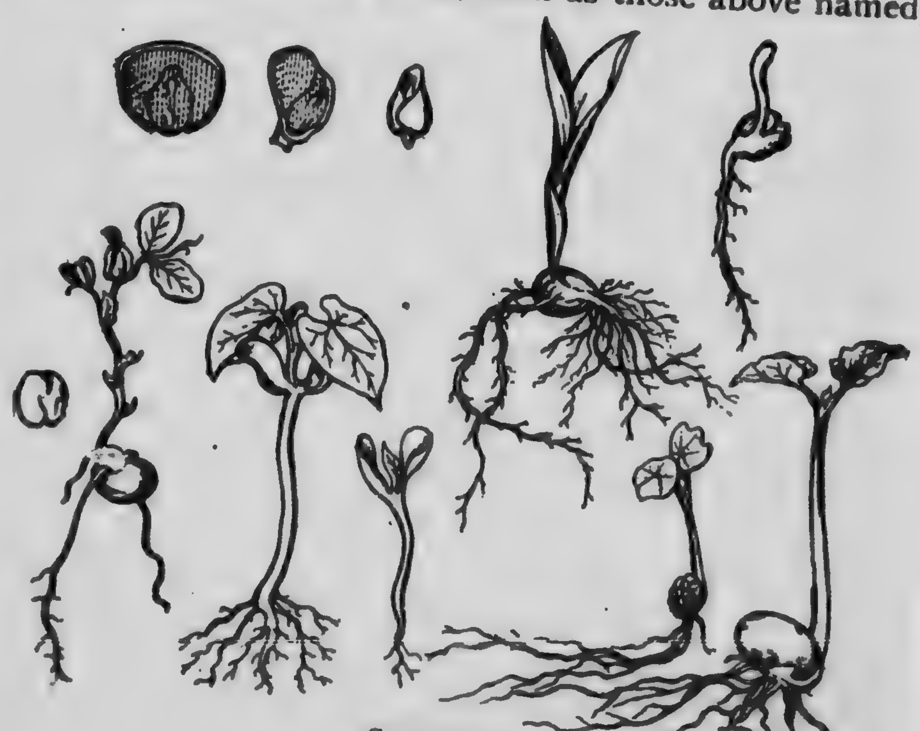
1. *The Hilum.*—The scar formed by the severance of the seed from the fruit-covering (pericarp).

2. *The Micropyle.*—A small opening close to the hilum, and which may be discovered by pressing a soaked bean between the fingers and noting the point at which the moisture oozes out.

For the study of seeds as above outlined, the following will be found convenient:—The Lima bean, the pea, the corn, the castor bean, the maple key, the pine and the horse-chestnut.

GERMINATION.

After the pupils have studied the parts of the seed, and made drawings of the same, then should follow the planting of common seeds, such as those above named,



GERMINATION.

and others, such as the radish and the onion. Some of these should be planted under varying conditions, as to light, air, warmth and moisture, for the purpose of discovering the essential conditions of germination. Plant a few of each in a box containing six inches of sawdust, and place it in a warm place in the sunlight. Moisten the sawdust daily. Each day one of the developing seeds may be carefully taken out and examined, for the purpose of noting what changes have taken place. The successive stages in the development of the bean, pea and corn, should be subjected to the closest scrutiny, and drawings made in a permanent note-book. These drawings should be numbered and accompanied by written explanations showing the time elapsing since planting.

The following questions will aid the pupils in their investigations:—

1. At what point did the seed-coat first break?

2. Which part of the kernel first emerged?

3. Which part of the seed first appeared above the surface?

4. In which seeds did the coat emerge above the surface?

5. Account for the seed-coat of the bean rising above the surface, while that of the pea remains under.

6. What becomes of the seed-leaves in the case of the bean and the pea?

7. What is the function of seed-leaves?

8. Similarly, what is the use of the albumen in the corn seed?

9. What has become of the plumule?

10. What has become of the caulicle?

11. What is the function of the plumule and of the caulicle?

NOTE.—This lesson on seeds and germination may be taken during winter and thus preparation made for the work of spring.

ROOTS.

This lesson follows logically that on germination in which the origin and development of the root system is easily observed. But the classification of roots as to form is better taken in the fall.

I. Origin.

The root has its origin in the caulicle of the seed. This, however, is not the only source of the root. Sometimes, as in the Indian-corn, the ivy and the strawberry, they originate in the stem which has developed.

II. Kinds as to Origin.

1. *Primary.*—When developed directly from the caulicle.

(*a*) *Multiple Primary* (fibrous).—When several are developed directly from the caulicle (grass).

2. *Secondary.*—When developed from a primary root.

3. *Adventitious.*—When developed from any part other than the caulicle (Indian-corn, ivy, strawberry).

III. Functions.

1. To absorb water and what it holds in solution, from the soil.

2. To fix the plant to its place.

3. To store up food, as in the carrot.

The absorbing function is carried on not through the root as a whole, but through very minute root-hairs. These are single-celled outgrowths from the newest parts of the root. They may be seen through a good lens and are found a very short distance back from the minute tip of each rootlet.

The little rootlet is wonderfully adapted to penetrate the soil by being furnished with a hardened cap, covering the tip and preventing the delicate inner part from destruction.

The relative growth of the different parts of a single primary root may be observed by taking a sprouted

bean, whose caulicle is about one inch long, and marking on this with Indian-ink lines a millimetre apart. Next attach a thread to the upper part of the seed and set the plant in an open-mouthed bottle with sufficient water to just cover the caulicle. Observe for a few days the increasing distance between these marks and infer where the greatest lengthening is taking place.

The adaptation of roots in their form and direction of growth to their function in the life of the plant, offers a subject of study for pupils of the higher forms, at once inspiring and helpful in an apprehension of the unity of life. The multiplied, elongated and tubular processes are especially fitted to penetrate the soil and conduct nourishment, while at the same time they are sensitive to the presence of moisture, as shown by their downward or lateral growth.

Contrast the flattened and expanded leaf-form with the form of roots, and look for the cause of this difference in the difference of function and environment of these organs.

Some roots grow for the most part laterally, while others grow deeply downward. Examine the position of the leaves on many plants with a view to discover the direction of flow from them of rain water relative to the axis of the plant, and then account for the two classes of roots as to the direction of their growth.

IV. Forms.

1. *The Tap Root.*—A thickened and prolonged primary root (dandelion).
   (*a*) Conical, as in the carrot.
   (*b*) Napiform, as in the turnip.
   (*c*) Spindle-shaped, as in the radish and beet.
2. *Clustered*, as in the peony and sweet potato.
3. *Necklace form*, as in the white clover.

The function of these fleshy roots in the economy of the plant may be determined through observing the life of a biennial, such as the carrot, from seed to fruit.

Stems.

I. Origin.

The stem has its origin in the upper part of the little body found in the midst of the cotyledons. Its development and germination should be carefully observed as it elongates and at intervals sends out leaves.

II. Appendages.

Stems bear buds, branches, leaves, flowers, tendrils and roots.

III. Functions.

1. To convey nourishment to leaves.

2. To carry elaborated material from leaves to where it is needed to build up tissue, or to be stored for future use.

3. To raise leaves and flowers to the light.

4. To store up nourishment, as in the potato.

5. To support the appendages named above.

For the purpose of showing its conductive power, cut across the stem of the geranium or other plant and immediately place this cut end in some water colored with some red dye. By cutting thin slices at intervals from this cut end, after some twenty or thirty minutes have elapsed, the rate of the upward movement of the water from the root may be seen, as well as the means of conduction.

IV. Classes as to Structure.

1. *Herbaceous.*—Soft, with little or no wood, and dying down to the ground each year.

2. *Woody.*—Plants with such stems are divided, according to their size and branching, into two classes, viz., shrubs and trees.

V. Structure of the Stem.

Cut across the stem of any herb, *e.g.*, a geranium, and with the aid of a lens examine the section. The following parts will easily be seen :—

(*a*) The bark (cortex and epidermis).

(*b*) The darkish dotted wood-bundles (fibro-vascular tissue).

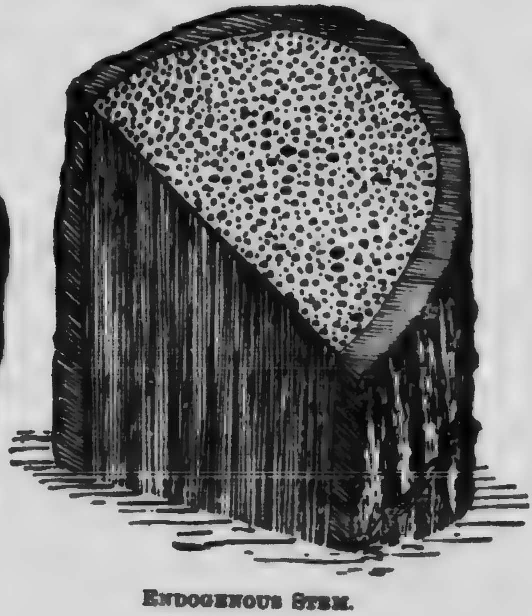
(*c*) The pith (soft, thin-walled, fundamental tissue).

VI. Kinds of Stems According to Arrangement of Wood-Bundles.

Examine cross-sections of the maple, oak, elm, beech and pine; also those of Indian-corn and sugar-cane. In the former, the wood is found to be arranged in concentric circles, each circle representing one period of growth, while, in the latter, the wood-bundles are not arranged in circles, but occur irregularly throughout the soft tissue of the stem. In the former, will also be noticed at the centre the *pith*, and radiating from this to the bark numerous lines formed of tissue similar to that of the pith. These are called the *medullary rays*. These rays are for the purpose of keeping up communication between the pith and the bark, in very young trees, and in conjunction with the concentric layers of the stem, give the grain to woods.

The stems of the maple, elm, oak, beech and pine, are said to be exogenous. Those of the Indian-corn, sugar-cane and the trillium, are endogenous. A comparison of

EXOGENOUS STEM.



ENDOGENOUS STEM.

the seeds of these two classes of plants will show that those having but one cotyledon (monocotyledons) will produce endogenous stems, while those having two or more cotyledons (dicotyledons or polycotyledons) will give rise to exogenous stems.

VII. Classes of Stems According to Position.

1. *Subterranean.*

These live underground, as in the fern, Solomon's seal, and early spring flowers. Such stems usually produce few, but large leaves. This position is one of good protection against cold and drought. Such stems are frequently covered with a woolly covering. This underground position is taken advantage of for storing food, and hence they are more or less thickened on this account.

(*a*) *The Rhizome or Rootstock.*—An elongated and thickened underground stem, and readily distinguished from the root by the presence of buds and scale-leaves, as in Solomon's seal, wild ginger, couch grass, bloodroot, and wild crane's bill.

(*b*) *The Tuber.*—A subterranean shoot, consisting of a short, swollen stem, bearing small scales and buds, as in the potato and Jerusalem artichoke.

(*c*) *The Bulb.*—A short, underground stem giving rise to many buds. Bulbs may be *scaly*, as in the lily and tulip, or *truncated*, as in the onion, or *solid* (corm), as in the Indian turnip.

Since the scale-leaf does not serve as foliage it does not develop the necessary green coloring matter (chlorophyll), and, therefore, does not need exposure to the light.

2. *Aerial.*

(*a*) *The Trailing or Running Type.*—As in the strawberry. While this type has an advantage in facility for migration and for propagating new plants, yet this is offset, to some extent, by a loss in power to display leaves.

Have the pupils examine the strawberry and the five-finger to discover how they vegetatively reproduce their kind and how they place the new plant in new soil.

(*b*) *The Climbing Type.*—These climb either (1) by twining, as in the hop and morning glory, or (2) by tendrils, as in the pea and the grape. This type is found mostly in the tropics, where the foliage is so dense as to exclude the light. Thus by climbing trees they expose their leaves to the light.

It is interesting to have the pupils discover the direction in which the hop twines about its support. Note similarly the morning glory. Note, also, if there is ever any variation in their respective modes of climbing.

(*c*) *The Erect Type.*—As in the maple, the oak.

SUGGESTION.—A most interesting and profitable work for rural schools is the making of a collection of all the different kinds of woods in the section or district. This can be done by securing branches of the larger trees, about two or three inches in thickness, and the largest stems of the smaller trees and shrubs. Cut from each a sample about one foot long, being careful to preserve the bark. Then carefully shave from three inches of the upper end a slice just deep enough to parallel the heartwood. Oil and varnish the whole piece; label and hang in a suitable place in the room.

BUDS.

A careful examination of vegetative buds in the spring as they develop will discover the fact that buds are but incipient shoots with their internodes condensed. This fact should be emphasized by requiring pupils to examine twigs of several years' growth to determine the amount of development from a single bud during one year, and the nature of the appendages from the position and forms of stem-markings.

I. Position.

1. *Terminal.*—At end of branch, *e.g.*, horse-chestnut, beech, birch.

2. *Lateral.*—On the side of the stem, *e.g.*, horse-chestnut, maple.

(*a*) *Axillary.*—Growing in the axil of a leaf, *e.g.*, ash, apple, maple.

(*b*) *Accessory.*—Two or more growing in addition to the one axillary. These may grow on either side of the axillary, as in the red maple and cherry; or they may grow above the axillary, as in the walnut and the butternut.

3. *Adventitious.*—Produced irregularly from branch or trunk or root, being often developed when the regularly-arranged buds have been destroyed, as in the willow.

NOTE.—*Require pupils to examine the branching of plants and relate this to the arrangement and development of buds.*

II. Covering.

1. *Scaly.*—Covered with dry, tough, bark-like layers (usually found in trees of northern climates), *e.g.*, horse-chestnut, maple, apple.

2. *Naked.*—Without scaly covering, *e.g.*, sumac, butternut, witch-hazel.

3. *Gummy.*—*e.g.*, horse-chestnut, balm of Gilead.

4. *Varnished.*—*e.g.*, willow, poplar.

This gum or varnish is evidently for the purpose of warding off water.

5. *Woolly.*—*e.g.*, sumac, and hickory.

This woolly material is for the purpose of guarding against too sudden changes. Note the woolly material surrounding the leaves and fruit of the bud of the horse-chestnut.

Sometimes buds are buried in the bark for purpose of protection. Examples are found in the locust, in the osage orange and in the sumac.

III. Kinds as to Contents.

1. *Leafbuds.*—Containing only leaves.
2. *Flowerbuds.*—Containing only flowers.
3. *Mixed.*—Containing both leaves and flowers.

A careful dissection of buds in the late fall or during the winter will show their contents. If the lesson is taken in the spring, the buds may be observed as they develop, and the contents may then be noted.

IV. Use.

(*a*) To develop aerial parts of plants, (*b*) to develop fruit.

V. Conditions of Growth.

(*a*) Light. (*b*) Warmth. (*c*) Air. (*d*) Nourishment.

By placing small twigs bearing buds under different conditions as to temperature, moisture, etc., the conditions necessary to development may be discovered.

A most interesting study for pupils is that of leaf-folding in the bud. In the packing away of leaves in the bud, the strictest economy is exercised.

Require the pupils to pick apart buds of various plants and observe the methods of folding as well as the relations of the leaves to each other. This latter can be well seen by taking a cross-section of the bud. Drawings should be made of these foldings and of the relative positions of the leaves to one another.

VI. Methods of Folding.

1. *Plane.*—When the leaves are not folded but lie flat one against another. Here the leaves are very small in the buds, *e.g.*, lilac.

2. *Plaited.*—Folded like a fan, *e.g.*, maple, mallow, beech.

3. *Conduplicate.*—Folded together along the midrib, *e.g.*, leaflets of horse-chestnut, elm, tulip.

4. *Convolute.*—Rolled from one margin to the other, *e.g.*, the pear.

5. *Involute.*—Rolled from both margins to the middle of upper surface, *e.g.*, balm of Gilead.

6. *Revolute.*—Rolled from both margins to the middle of lower surface, *e.g.*, dock, willow.

7. *Circinate.*—Rolled from apex to base, *e.g.*, the fer

Buds develop into branches simply by lengthenin their internodes. If the terminal bud contains onl inflorescence, the onward growth of stem is stopped an lateral buds form below it and develop into branches.

Foliage Leaves.

I. Position.

Above ground and in the light.

II. Color.

Generally green. This green is due to the presence of small granules of green matter (chlorophyll) in the cells of the leaf. The green color disappears gradually when the plant is removed from sunlight.

III. Form.

A thin, flattened and expanded organ, and thus well adapted to secure exposure of the largest possible surface to sunlight.

IV. Shape.

Leaves present a vast variety of shapes. There are all gradations in general contour between the needle form of the pine and the circular form of the nasturtium, besides a diversity in marginal indentation from the entire, through the lobed and cleft, to the compound.

The above characteristics of *position*, *color*, *form* and *shape* are not accidental properties, but rather modes that the plant, as a living organism, assumes in adapting itself to its environment. Its position above ground is well fitted to secure for it light, while the flattening and expansion of the organ further assist this end. The chlorophyll bodies can perform their function only in the presence of sunlight. The general shapes of leaves, their lobing and compounding, as well as their size, length of petiole and relative arrangement, are controlled by the necessity for light. This may be seen by a careful examination of a spray of maple in which

the length of petiole and the size and position of the leaf are controlled by conditions of light.

V. Parts.

1. The blade.
2. The petiole.
3. The stipules.

The only essential part of the leaf is the blade. Many leaves have neither petioles nor stipules. Stipules may be seen in the round-leafed mallow and in the apple.

VI. Functions.

(*a*) In the presence of sunlight, the green part unites the carbon dioxide taken in by the leaf from the air with water carried up by the stem from the root or inhaled by the leaves as vapor, forming starch and liberating oxygen. The starch is retained by the plant to build up its tissues and the oxygen is given off to the air.

(*b*) The leaf, like animals, is constantly, during both night and day, taking in oxygen from the air and uniting it with the tissues, forming carbon dioxide and water. The carbon dioxide is given forth to the air. This process is called *respiration*.

(*c*) Part of the water absorbed by the roots is given off to the air after it has served the needs of the plant. This process is *transpiration*.

VII. Venation.

(*a*) *Net-veined.*—When the leaf has one or more main ribs each in turn branching and rebranching in smaller ribs or veins until the blade presents the appearance of a network, as in the maple.

(*b*) *Straight-veined.*—When the veins are in parallel lines either from the midrib to the margin, as in the calla lily, or, where no midrib is present, from the base to the apex of the leaf, as in the grasses, and the lily of the valley.

Uses of Veins or Strands.—(1) They give support to the soft tissue of the leaf. (2) They serve to conduct materials to and from the green substance.

VIII. Kinds of Blade.

(*a*) *Simple.*—Consisting of but one part, however, deeply cut, *e.g.*, maple, oak and dandelion.

(*b*) *Compound.*—Consisting of several distinct leaflets, *e.g.*, horse-chestnut and pea.

A compound leaf is only a simple leaf, so deeply cut as to form the blade into separate leaflets whose main ribs are the secondary ribs of the simple form.

Simple leaves are of two kinds (*a*) ***pinnate***, where there is but one main rib, as in the pear and elm; (*b*) ***palmate***, where there is more than one main rib, as in the maple.

Compound leaves are classed as ***pinnately compound*** or ***palmately compound***, according as the leaflets are arranged pinnately or palmately.

IX. Relation of Size and Shape to Number and to Grouping on the Stem.

In the case of leaves whose blades are entire and large, but little light can pass between them, to the lower strata, and as a consequence the leaves on such a plant are fewer than on a plant of similar size with its leaves small or much cut or compounded. In the latter case, the sunlight can penetrate the interspaces and give life-power to the leaves beneath, and, therefore, a greater number of leaves will be found throughout the stems.

On erect stems in plants whose leaves are undivided, the leaves either generally diminish in size towards the top or the lower leaves develop longer petioles. In this case the contour of the plant is conical. But generally, where the leaves are much cut or branched, the plan of the plant will be cylindrical.

Observe the general contour of trees, like the maple and elm, on the one hand, and the poplar, balsam and

larch, on the other, comparing the general branching of the trunk with the varying length and position of the petioles of the leaves in the simple herb.

X. Insertion.

(*a*) *Petiolate.*—Having a petiole. (*b*) *Sessile.*—Where there is no petiole.

Generally a wide-based leaf has a long petiole, *e.g.*, maple, buckeye. Leaves near the ground on simple, erect herbs, usually either have long petioles or long blades narrowing towards the point of attachment.

Note the varying lengths of petioles of the leaves on a maple spray; also the varying sizes of such leaves for the purpose of securing exposure of greatest leaf-surface, without shading.

XI. Arrangement.

(*a*) *Alternate.*—Only one springing from a node, as in the elm.

(*b*) *Opposite.*—Where two spring from a node, as in the maple.

(*c*) *Whorled.*—Where more than two spring from a node, as in the trillium and catalpa.

(*d*) *Bundled.*—Several in a bundle, as in the pine.

On erect stems, when leaves are broad, there are few vertical rows; the narrower the leaf the more numerous the vertical rows.

XII. Surface.

(*a*) *Smooth*, as in the maple.

(*b*) *Rough*, as in the elm.

(*c*) *Hairy*, as in the geranium.

(*d*) *Spinous*, as in the thistle.

These hairs and spines are doubtless for protection against too intense light, heat or cold, or against insects and other animals.

XIII. Position in Relation to Light.

Observe the position of leaves of plants growing in a window. Change the position of the plant in the window and observe the change in leaf position.

The leaf position relative to sunlight is either (*a*) *fixed*, or (*b*) *variable*. In the latter case the position of the leaf changes with a change in the direction of the light.

(*c*) The forenoon position may be different from the afternoon position.

(*d*) The day position is different from the night position, as in the sensitive plant and other mimosæ. Carefully examine the prickly lettuce, a common weed, and account for the peculiar position assumed by the leaves.

XIV. Leaf Structure.[1]

A cross-section through the leaf shows usually five layers, viz.:

1. *The Cuticle.*—A layer for protection against too great light and heat, and for the shedding of water.
2. *The Epidermis.*—Usually of thick-walled cells for protection. This contains no chlorophyll.
3. *The Palisade Tissue.*—Usually elongated, green cells, with the long axis perpendicular to the epidermis for the protection of the soft tissue from too great light.
4. *The Soft, Spongy Tissue.*—Green cells with intermediate air-spaces.
5. A lower row of palisade tissue (sometimes).
6. *Lower Epidermis.*

There are minute openings through the epidermis of the leaf, sometimes on the under side only, through which the leaf transpires and carries on the interchange of gases. These openings are called stomata.

XV. Leaf Protection.

The leaf as a part of a living organism has its dangers, and adapts its life to meet them. The dangers are those of too intense light, too intense heat, drought or cold; also from animals and from rain.

These dangers are met in two ways. *First, by the development of protective structures between the air and the delicate inner tissue · second by a lessening of exposed surface.*

Under the first kind of protection there are:—

(*a*) Development of cuticle.

(*b*) Development of palisade tissue.

(*c*) Thickening of the epidermis.

(*d*) Development of hairs and spines from the epidermis.

Under the second form may be noted.

(*a*) Diminution of leaf-size in hot regions, *e.g.*, the sage bush.

(*b*) Reduction of leaves to mere spines, as in the cacti.

(*c*) The rosette grouping of leaves for purposes of shading, or of checking too great radiation of heat in plants growing in exposed situations.

(*d*) Protective positions, as the edgewise position of the leaves of the prickly lettuce; the night and day positions assumed by some cotyledons in early stages of germination, *e.g.*, the bean; and the winter and summer positions of the leaves of the juniper.

XVI. Leaf Fall.

The primary cause of leaf fall is the drying up of those sources from which the transpiring leaves derive their water. This cessation of the absorbent function of the little rootlets is brought about in temperate climes like southern Canada, by the lowering of the temperature of the soil. When the soil temperature is lowered to about 38° F. the rootlets cease to absorb, and the leaf in consequence of the fact, that its loss of water through transpiration cannot be replaced, discolors and withers.

The separation of the leaf is effected by the formation of a transverse layer of soft walled cells across the petiole where it joins the stem in most simple leaves as well as across the stemlets of each leaflet of the compound.

This layer of separation begins to form immediately on the cessation of transpiration from lack of water.

The leaves of trees of the same species, but in different locations, do not change their color and fall at the same time. In the case of trees like the maple, birch, aspen and beech, the discoloring and falling of the leaves is accomplished much earlier when located on a sunny hillside than when in a shady, humid glen.

(*a*) Account for this in the light of the facts given above.

(*b*) Observe the falling of the leaves of the horse-chestnut, maple, elm, ash, grape, Virginia creeper and English ivy. Where does the separation first take place?

(*c*) Why do many leaves fall on a warm morning following a heavy frost?

(*d*) Why do the leaves of a branch torn from a tree in summer, wither and fade? Do they separate from the branch? Give reasons for your opinion.

REPRODUCTION.

I. Methods.

1. *Vegetative.*—(*a*) By bulblets—tiger lily, onion.

(*b*) By underground stems—raspberry, Solomon's seal.

(*c*) By runners—strawberry.

(*d*) By slips or cuttings—willow, ivy, geranium.

(*e*) By leaf-buds (buds formed in the notches of the margins of the leaf, or at the cut ends of the ribs)—tuberous begonia.

(*f*) By bulbs—crocus, lily.

2. *By Seed or Spore.*—The end and purpose of the life of the plant seems to be to reproduce its kind. To this end it works by storing up nourishment, by various modes of growth, and by protective provision against unfavorable conditions and animals. The struggle for existence will explain the variation in plant structure and habit.

The Flower

I. Function.

To produce seed.

II. Parts.

- 1. Protective Organs.
  - (*a*) Calyx (sepals).
  - (*b*) Corolla (petals).
  - (Calyx and Corolla together:) Perianth.
- 2. Essential Organs.
  - (*a*) Stamens.
    - Anther (pollen).
    - Filament.
  - (*b*) Pistil.
    - Stigma.
    - Style.
    - Ovary (ovules).

III. Kinds of Flowers.

1. *Perfect.*—Having both stamens and pistil.

2. *Complete.*—Having all the parts possible to a flower.

3. *Regular.*—Having in each circle each part of the same size and shape.

4. *Symmetrical.*—Having each circle contain the same number of parts or a multiple of that number of parts.

IV. Imperfect Flowers.

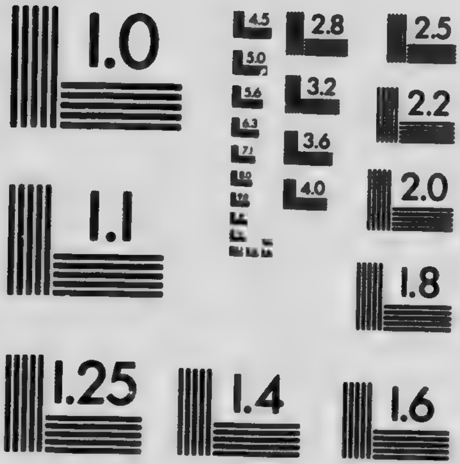
1. *Staminate.*—Those containing stamens, but no pistil.

2. *Pistillate.*—Those containing pistils, but no stamens.

Some plants produce only either staminate or pistillate flowers. Examine the *willow* in the spring. Other

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



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plants, such as the *witch-hazel*, the *oak* and the *Jack i[n] the pulpit*, produce both staminate and pistillate flower[s] on the same plant.

In order that seed may be produced, the pollen of [a] flower must come into contact with the stigma (*a*) of th[e] same flower, or (*b*) of another flower of the same kind[.] The former is called self-pollination; the latter cross[-]pollination. Cross-pollination is the method preferre[d] by nature. Stronger seed is in this way produced[,] especially when the pollen is transferred to flowers o[n] different plants.

V. Means by which Cross-Pollination is Effected.

(*a*) Wind. (Anemophilous.)

(*b*) Water. (Hydrophilous.)

(*c*) Insects. (Entomophilous.)

VI. Characteristics of Anemophilous Flowers.

1. Pollen produced in great abundance, since much of it must be wasted; *e.g.*, pine.

2. Pollen is dry and floury, not sticky.

3. Flowers small and inconspicuous.

4. No honey or perfume.

5. Frequently the stigmas branched and feathery to catch the pollen grains.

VII. Characteristics of Entomophilous Flowers.

1. Conspicuous corollas, or flowers arranged in conspicuous inflorescences.

2. Usually secrete honey and give out perfume.

3. Pollen not produced in such abundance as in anemophilous flowers, since provision for transference is more perfect.

4. The forms of the flowers adapted in a variety of ways to receive insect visitors. Examine flowers of the pea family and of the mint family.

VIII. Classes of Flowers According to Relative Position of Perianth and Stamens and Pistil.

(*a*) *Hypogynous.*—When stamens, petals and sepals are inserted on the side of the receptacle below the pistil (gynœcium).

(*b*) *Perigynous.*—When the pistil (gynœcium) is developed in the middle of the disk of the receptacle and the stamens, petals and sepals are around the rim or margin.

(*c*) *Epigynous.*—Where the calyx tube forms the ovary wall and the stamens, petals and sepals spring from the upper part of the pistil.

IX. Color in Flowers.

Color in flowers is evidently closely connected with the work of fertilization. It serves to attract such insects as are suitable for effecting pollination. While nature appears lavish in her display of color, a closer study will reveal the strictest economy; *e.g.*, when the flower is large and colored, it is usually solitary; but, if the flowers be small, they are generally grouped in bunches, spikes, racemes, umbels, and capitulas. Great use is also made of contrast of colors in the flower. This contrast offers much greater attraction for the insect. Examples of contrast are very numerous; a few prominent cases will serve to illustrate.

(*a*) In many willow herbs, the white cross of the stamens appears on a red background.

(*b*) In the borage officinalis, a black cone of anthers rises from a blue star.

(*c*) In the bitter-sweet (*Solanum dulcamara*), a yellow cone of anthers rises from a violet star.

(*d*) In the hepatica triloba a white centre is seen on a blue ground.

(*e*) In the mullen (*verbascum*), the stamens have violet hairs contrasting with light yellow corolla and orange anthers.

(*f*) The white coronas of some varieties of th narcissus are surrounded by a cinnabar-red border.

(*g*) In many compositæ, disk and ray flowers are o different colors, *e.g.*, daisy, asters.

FRUIT.

A fruit is a ripened ovary, together with whateve organs adhere to it. Within the ovary wall are foun the seeds, and attached to it are frequently other flora organs or their parts. The ovary wall is called th pericarp. An examination of the apple will shov that the edible portion consists for most part of th calyx and of the receptacle, while the fruit of the straw-berry consists almost wholly of the swollen receptacle.

I. Kinds of Fruits.

(*a*) *As to composition.* 1. *Simple.*—Resulting from the ripening of a single pistil. The matured ovary may be either accompanied or unaccompanied by other floral parts, *e.g.*, ***plum***, ***peach***, ***pear***, ***gooseberry***.

2. *Aggregate.*—Resulting from the crowding into a mass, of the carpels of the same flower, *e.g.*, ***blackberries***.

3. *Accessory.*—When the calyx or receptacle forms part of the fruit mass, *e.g.*, the ***strawberry***.

4. *Multiple or Collective.*—When formed from several flowers collected into a mass on a common receptacle, this receptacle forming part of the fruit, *e.g.*, ***pineapple***, ***mulberry***.

5. *Stone Fruits, Drupes, or Fleshy Fruits.*—A berry-like fruit with a stony, nut-like centre, *e.g.*, the ***peach***.

6. *Dry Fruits.*—Without any pulpy surrounding mass, *e.g.*, the ***hickory***.

(*b*) *As to opening of fruit for purpose of liberating its seed.* 1. *Dehiscent.*—Opening to discharge seed, *e.g.*, the ***pea***.

2. *Indehiscent.*—Not opening to discharge seed, *e.g.*, the ***peach***.

It will be observed that the fleshy fruits are all indehiscent, while the dry fruits may be either dehiscent or indehiscent.

Fleshy fruits include the *berry*, *e.g.*, currant, tomato grape, orange and pumpkin; the *drupe*, or stone fruit, *e.g.*, peach, cherry; the *pome*, *e.g.*, apple, pear.

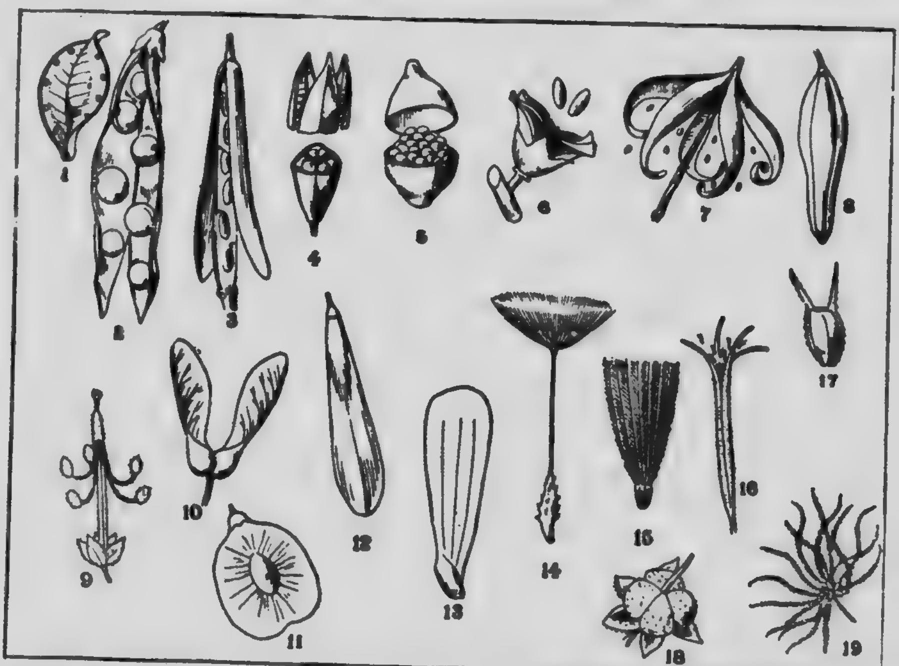
Of dry indehiscent fruits, the chief are the *achene*, *e.g.*, the buttercup fruit and the seed-like bodies on the surface of the strawberry; the *caryopsis*, or *grain*, differing from the achene only in having the seed adherent to the pericarp throughout, *e.g.*, wheat, corn; the *nut*, generally one seeded and with a hard, bony shell, *e.g.*, the cocoanut, the chestnut, the acorn; the *samara*, or *key*, either a nut or achene furnished with a wing for transmission through the air, *e.g.*, the ash, the elm, the maple.

Of dry dehiscent fruits the chief is the *pod*. This may be either (*a*) a *legume*, resulting from the ripening of a single ovary and opening either down but one side, as in the marsh marigold, or down both sides, as in the pea and bean, or breaking crosswise between the contained seeds, as in the desmodiums; or (*b*) a *capsule*, resulting from the ripening of a compound ovary, and liberating its seeds either through its sides or through an opening in the top, *e.g.*, the poppy, the snapdragon.

The fruit forms a most interesting subject for children, when studied not from the standpoint of classification, but in its relation to the life of the plant. It is the means by which the plant continues its existence, and its production becomes the end towards which it works. The parent plant analyzes the various constituents taken from soil and air and under the action of sunlight synthesizes the resulting elements into assimilable material, uses this for present requirements in strengthening its organs, or stores it for future use; it sends forth its flowers with their attractive colors and odors, soliciting the aid of insects in the fertilization of its ovules—all this that vigorous fruit may be produced and its life continued in a numerous progeny.

But not less interesting is the study of tne varie means used by nature to provide for the maturity an distribution of this fruit. It must guard against its de struction by predaceous animals and provide means fo its safe dispersal at a distance from the parent plant.

This protective provision of nature is seen in the colo assumed by fruits in their early development, as well a in the distasteful, acrid or bitter juices which the contain. The greenness of the apple, plumb, pear butternut, as well as their forbidding taste, in immaturity is no accident but a wise provision of nature to assure to them a development commensurate with the great work they are to perform. Once maturity is reached the ani- mal creation is again, in many cases, appealed to. The unattractive green is changed into the brightest colors and the bitter juices into such as are palatable to the life, most suited to the dissemination of seed.



1 and 2—Legume; 3, 4, 5, 7 and 8—Capsule; 6—Nut; 9—Mericarps (geranium); 10—Double Samara; 11 and 12—Single Samara; 10, 11, 12 and 13—Winged Fruits; 14 and 15—Fruit with Pappus; 16—Crested Seeds of Willow Herb; 17 and 18—Fruit with Hooks; 19—Bearded Seeds (clematis).

Many other equally interesting and profitable topics of study on the fruit will be suggested as the work of careful observation progresses, *e.g.*, the prevailing shape of fruits and the search for the underlying purpose, the relation of fruits, their form and composition to the migration of plants.

Dispersion of Seeds.

Seeds are dispersed by the following means :—

I. Wind.

Nature has made special provision for this, as in the following cases :—

(*a*) Seeds with *wings*, as in the maple, birch, elm, ash and pine.

(*b*) Seeds with *down*, as in the dandelion, milkweed, thistle, fireweed and clematis.

(*c*) Seeds which when *moist adhere* to such objects as leaves and become scattered by the wind, as plantain seeds.

(*d*) Profusely branching plants with small root-systems, as the *tumble weeds* or *field rollers*, which scatter their seeds as they are rolled along.

II. Water.

Many seeds float on water and are carried long distances by currents.

III. Animals.

(*a*) Seeds with *hooks* adhere to animals and are carried far from the parent plant, as the burdock and the hound's tongue.

(*b*) Birds eat the fleshy part of many fruits and drop the seeds far from their place of growth.

(*c*) In some *stone* fruits, as in the mistletoe, the stones adhere to the bill of the bird and are wiped off on the branch or trunk of some tree, as the oak, on which they germinate.

IV. Mechanical Discharge.

In this case, the walls of the seed-vessel press upo the seeds so that, when it opens, they are shot to a co siderable distance, as in the witch-hazel, lupine, touc me-not and violet.

SCHOOL GARDENS.

Situation.—School gardens should be (*a*) within th school grounds or near enough to them to make convenient for the pupils to visit them frequently, i order that they may watch the development of plant from their first signs of germination to the perfectio of blossom and fruit.

(*b*) If possible, they should be in the rear of the schoo or in a part of the yard where the child's attention wi be least distracted.

Size.—(*a*) In graded schools, they should be larg enough to keep a class of about twenty, at work at th same time, examining the different plants as arrange for study.

(*b*) The size of the George Putnam school garden Boston—the first school garden in the Eastern States— was forty-eight by seventy-two feet. Where the space is limited, however, or where the bed has to be cut out of the lawn or playground, the most convenient size has been proved to be beds of four feet by twenty feet.

Arrangement.—(*a*) Plants must be arranged as growing *naturally*. No attempt should be made, as in our public gardens, at arranging plants to bring out designs, such as symbols of trades, mottoes, portraits of distinguished men, etc. Nor should any attempt be made to establish so-called "fine gardens" with ornamental flower-beds.

(*b*) The best arrangement for many kinds of plants is in rows in long, narrow beds. They can then be exam-

ined by the pupils standing on each side of the bed. The rows ought to be from four to five inches further apart than the width of a narrow rake.

(*c*) By arranging along a wall or a fence in a serpentine border plants that require the sunlight and plants that require the shade, considerable ground may at times be economized. The part of the curve nearer the fence should be reserved for plants requiring shade. Tall plants and those requiring the full sunshine should be planted in the part of the curve which is farther from the fence. This serpentine border has also other advantages. More pupils can be kept at work than if the border were straight. The practical can also be strengthened by preserving the artistic. The curve is always more attractive and effective than the "straight line."

(*d*) To arrange the different species of the same genus in irregular clusters has been found to have advantages.

(*e*) In the Botanical Gardens in Edinburgh, Scotland, a long, narrow bed with the different families of plants, arranged in alphabetical order and in clusters according to the initial letter of their name, no other basis than the family being considered when classifying them, is reserved especially for the students of the Edinburgh University.

(*f*) Plants should be distributed so as to use every available inch of ground, *e.g.*, ferns thrive well in an angle of the school building, in a shady, sheltered position or in a fence corner, and gourds, as melons, pumkins, may be planted between tall plants.

(*g*) To reserve a square yard of ground for each of the ordinary grains—wheat, rye, oats, barley—will be found sufficient for all practical school purposes.

Kind of Soil.—This must be such as the school-yard affords. If the plants do not thrive, the pupils should discover the cause. Should the soil require enriching,

they should endeavor to find out the kind of food th weak plants require.

Children should be encouraged to bring wild plan for the school garden. Before transplanting them, th pupils should be taught to observe the situation and kin of soil in which they are growing and to note that th same conditions are necessary for the health and de velopment of the plant in the school garden.

Preparation of Soil for Seeds and Plants.—The dig ging of the garden and the planting of seeds and plant should, as far as possible, be done by the pupils, bu generally under the supervision of the teacher. Eacl pupil should be held responsible for some definite par of this work.

Kind of Plants Suitable.—Plants cultivated by a floris are not the kind of plants most suitable for a school gar- den. The main contents of such a garden should be plants especially suitable for teaching purposes. The following are recommended:—

(*a*) *Native plants*—hepatica, trillium, violet, aster, sunflower.

(*b*) *Economic plants*—grains, garden vegetables, pease, beans, melon and cucumber.

When arranging the different plants in beds and borders, the child's love for *beautiful bright colors* should receive a certain degree of consideration. If a little thought is given in planting flower-beds, it is possible to keep them bright throughout the season, *e.g.*, plants blooming in September should be planted two feet apart, and those blooming in the early part of the summer should be planted between these.

Care of the Garden.—(*a*) The general management should be the duty of the teacher. The sympathy of the trustees should be enlisted. It is frequently necessary to call upon them to meet the consequent running expenses. Many advantages are to be gained

by keeping in touch with the horticultural society of the district.

(*b*) The *weeding* and *watering* should be done by the pupils. If at all possible, each pupil should have a plant, or a group of plants under his special care. He should also be encouraged to make a garden at home.

The weeding and the watering should not be done in an entirely mechanical way. The different kinds of weeds, how they propagate themselves, and how best to eradicate them, should always be kept before the minds of the pupils.

The difference between sprinkling and watering a plant, how to save the water already in the soil, and the amount of water required by the different plants, are considerations that should constantly appeal to the intelligence of the child.

(*c*) In the fall, seed-vessels should be collected for winter study, and bulbs, corms and tubers stored away for spring planting.

Mounted Specimens.—During the summer, the children should collect specimens of leaves, ferns, flowers and fruit from the garden. These should be mounted on sheets of paper. The standard size of mounting paper is eleven and a half by sixteen and a half inches. The specimens should be labelled.

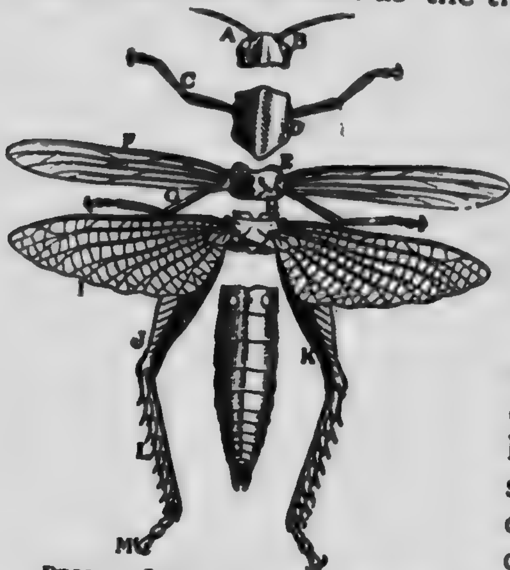
CHAPTER III.

INSECTS.

Ah, look thou largely, with lenient eyes,
  On whatso beside thee may creep and cling,
For the possible glory that underlies
  The passing phase of the meanest thing!

—*A. D. T. Whitney.*

The study of insects seems to have had a recognize place even as far back as the time of Solomon. "Go t the ant, thou sluggard consider her ways, an be wise." Prov. vi., 6 Until recent years, how ever, such a study wa considered altogetherou of the province of th child.



PERFECT INSECT—GRASSHOPPER (type).

A—Antennæ.
B—Eyes.
C—1st pair of Legs.
D E H—Thorax.
F—1st pair of Wings.
G—2nd pair of Legs.
I—2nd pair of Wings.
J—3rd pair of Legs.
K—Abdomen.
L—Tibia.
M—Tarsus.

In schools where the study of nature has a definite place, teachers have noted that the study of the life-history of insects can be easily carried on. The gathering of eggs and the watching of their development through the larval and pupal stages to the perfect insect have a special charm for children. In addition to the ease and interest of the study, it possesses the following advantages:—

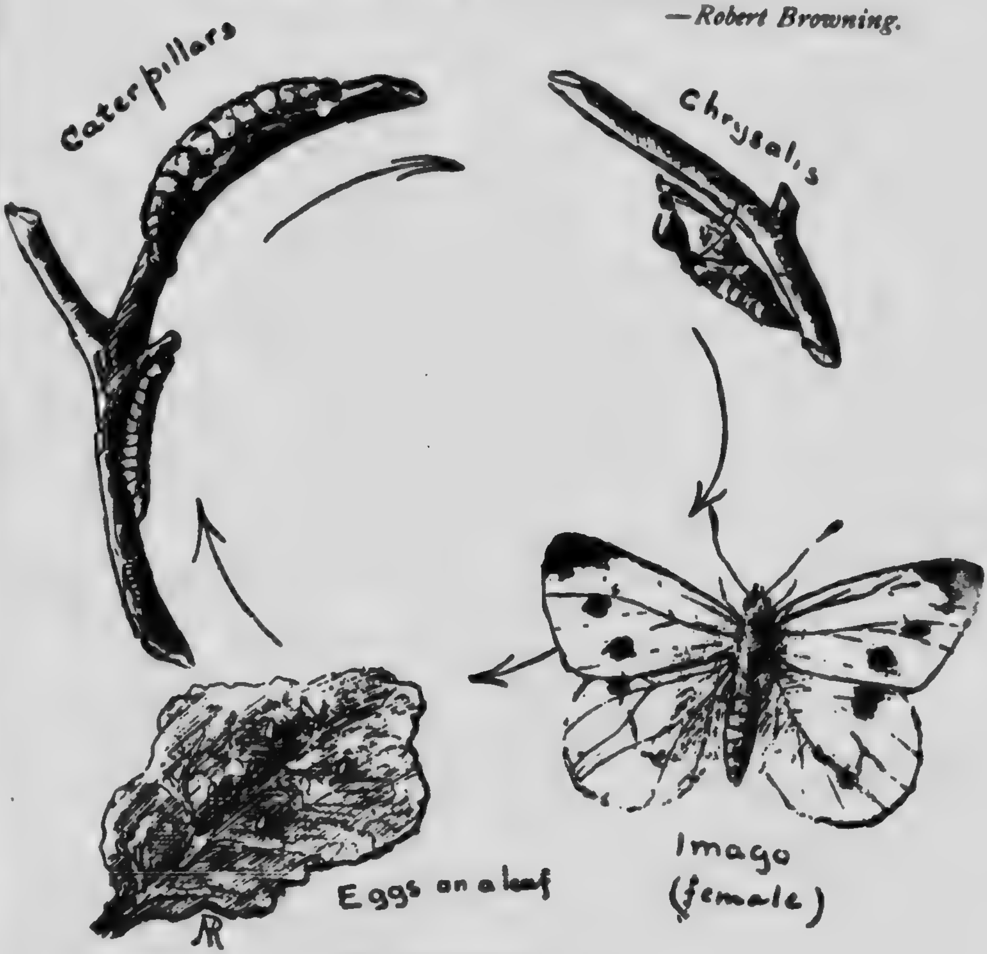
1. It leads the child to a higher and truer conception of nature, through a recognition of the perfection and greatness of her apparently insignificant forms.

2. It gives knowledge, necessary to success in agriculture and fruit-growing. Sometimes fruit-trees, giving in spring prospects of a rich harvest, fail to produce any crop. Had the owners been acquainted with the mode of life of the insect that caused the disappointment of their hopes, the loss might have been prevented.

Collecting and Preserving Insects.

He, out of nothing, made sky, earth and sea,
And all that in them is—man, beast, bird, fish,
Down to this insect on the parapet.
Look how the marvel of a minim crawls!

—*Robert Browning.*



The Cabbage-Butterfly.
Showing its Life-History.

By collecting and preserving insects, the child observ much that would otherwise escape his attention. A every step, he feels that "he learns by doing," "he se by seeing."

So work the honey bees;
Creatures that by rule in Nature teach
The art of order to a peopled kingdom.

—*Shakespeare.*

The world is teeming with insects. Everywhere they are found—on flowers, on leaves, on trees, in rotten wood, under chips and stones, in rocks and crevices— and few plants, if any, are so mean as not to be the home of some insects.

It requires little technical skill to preserve insects. They are easily caught and killed and can be preserved with little trouble.

How to Collect Insects.—To construct an insect net, make a bag of mosquito-netting, or cheese cloth, about eighteen inches long, rounded at the bottom. Fasten it to a galvanized wire ring about a foot in diameter. In making the ring, leave enough wire to fasten it to a handle. A piece of an old broom-handle or a bamboo fishing-rod, about three feet long, answers very well.

Insect Net.

In collecting insects that live among the grasses and long weeds, the best way to use the net is to push it before you, turning it lightly and quickly from side to side to prevent the insects caught from escaping.

In collecting insects from bushes and trees, shake the bush or the limb of the tree, holding the net under it.

Insects that live in water are best collected with a sieve having a long handle. For a few cents a tinsmith will fasten a tin with a sieve bottom to a long handle; a piece of a broom-handle will answer very well. Insects that fly at night can be easily baited with sweet syrup smeared on a tree trunk, or attracted by a lamp near a window on a warm evening.

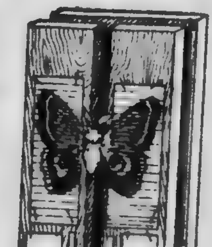
Insects that live under stones or under rotten wood can be caught very easily by placing the net in such a position that the insect will be forced to go into it.

How to Kill Insects.—Impress upon the child that insects are highly nervous creatures and that it is cruel to kill them in any way that prolongs their suffering. If killed in the following way they will be stunned almost immediately: Take a wide-mouthed bottle, say an ordinary pickle bottle, with a well-fitting cork, long enough to be taken out and put in with ease. Into this bottle drop a couple of cents' worth (three lumps the size of a small marble) of cyanide of potassium. Then pour in sufficient water to cover the bottom to a depth of half an inch. Sprinkle in enough plaster of Paris (one or two cents' worth) to absorb the water. As soon as the plaster of Paris forms a dry cake, cork the bottle and it is ready for use.

Poison Bottle. (*Riley.*)

Several insects may be put into the bottle at the same time. They should be left in about an hour at least. Do not breathe the fumes from the bottle; they are poisonous.

The following is also a successful method of killing insects:—Into a wide-necked bottle with a close-fitting cork, put half an inch of cotton-batting, then cut circles of blotting-paper to fit tight over the cotton and press them down. Put in enough gasoline or chloroform to wet the cotton-batting through. On placing the insect in this bottle, it will be killed almost immediately and the color will not be injured. From time to time the gasoline or chloroform should be renewed as required.



A Spreading Board for Drying Lepidopterous Insects. (*Anna B. Comstock.*)

How to Preserve Insects.—All insects except beetles should be pinned through the part of the

thorax just back of the head, with insect pins. If these are not available, use japanned pins. Common pins are apt to corrode and consequently to injure the specimens with verdigris. Beetles should be pinned through the right wing. Sheets of cork or pieces of linoleum make good lining for the bottom of boxes in which insects are kept. These boxes should be made very tight and lumps of camphor or naphtha should be always kept in them to prevent the destruction of the specimens by museum pests.

Beetle, pinned

When pinning butterflies stretch the wings and dry them. This may be done in the following way: Take two strips of thin wood; tack them ⅛ inch apart at one end, ½ inch apart at the other, on two crosspieces. Line the groove beneath the strips with sheet cork. Insert the body of the butterfly between the strips and pin it to the underlining cork. Spread the wings with narrow strips of cardboard and pin them so that the line between the front and hind wings will be nearly perpendicular to the body. Leave the insect in this position until it is rigid and dry.

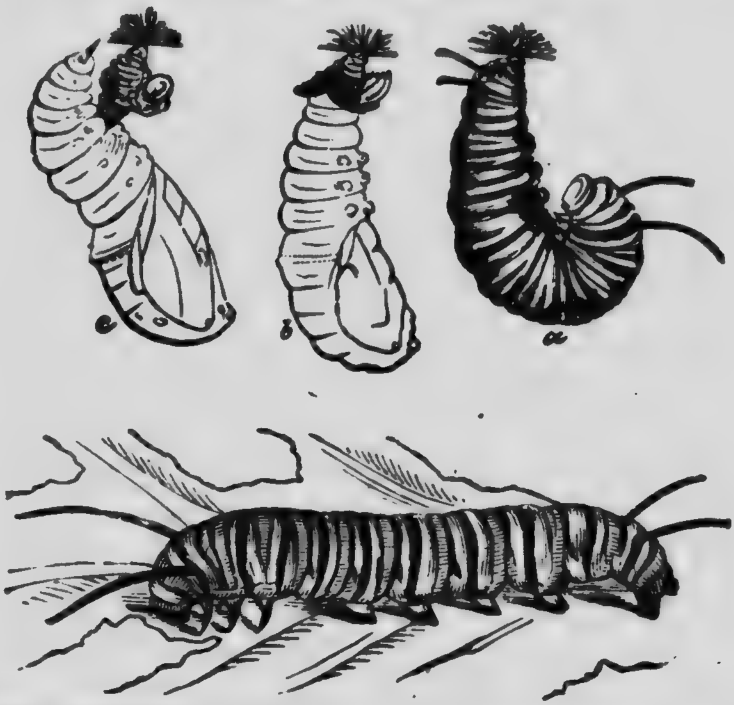
How to Label Insects.—Cut the labels as neat and small as possible. Finished labels, if desired, may be obtained at a druggist's. Slip the paper upon the pin with which the insect is pinned and place it below the insect. Label thus:—(1) Name of insect, (2) where caught, (3) date of capture.

Tortoise-shell Butterfly,
Toronto, Ontario,
July 25th, 1901.

Larva or Caterpillar.

How to Rear Larvæ or Caterpillars.—During August, collect a number of larvæ of different kinds. Put one of each kind in a box covered with netting. In the bottom of the box, put several inches of sand and chips. Be

careful to keep in the box plenty of fresh leaves of the plant upon which the larva was found.



Stages in development of the caterpillar of the Milkweed-Butterfly. (*Riley.*)
(*a*) First Stage. (*b*) Second Stage. (*c*) Third Stage.

By September or before the end of August many of these larvæ will be fully grown. They will probably have changed their skins several times. This is a process that will be most interesting for the children to note. Some of these larvæ will transform themselves into chrysalids and suspend themselves from twigs, which should also be put into each box. Others will spin cocoons of silk and other substances, while others will doubtless burrow in the ground. Possibly some may creep into a crack in the box and remain dormant a long time.

By early spring or probably during winter, the pupils may experience the great delight of seeing the imago emerge from its prison.

In spring, the larvæ of many different kinds will found feeding on the young leaves. Each plant, it m be said, has its own peculiar species of caterpillar.

And there's never a leaf nor a blade too mean
To be some happy creature's palace.

—*Lowell.*

Some of these larvæ have been hatched from eg deposited at a previous time, doubtless during the pr ceding summer or autumn, by the full grown insect; while others, which we hatched last autumn, have come out their winter hiding-places. These larv may be treated similarly to those co lected during the autumn.

Chrysalis of the Milk-weed-Butterfly.
(Riley.)

Potato-beetles are particularly inte esting, as the whole potato-plant can b grown in a box, and the entire deve opment observed from the time th beetle lays its eggs upon the leave until these develop into larvæ and th larvæ become beetles.

Caterpillars that live in companies, such as tent caterpillars, can be studied with satisfaction on a branc transferred to a large box and kept in a bottle of wate

The larvæ of the clothes-moth furnish a useful anc indeed, an interesting study. This little moth deposit its eggs in furs and woollen goods. Wool-upholsterec furniture is a favorite place.

If fully developed insects are caught and imprisoned their eggs will be deposited where the pupils can watch their development from the very beginning.

Different Names Applied to Larvæ.—The larvæ of beetles are frequently spoken of as borers or grubs; those of flies as maggots; those of grasshoppers as nymphs; those of butterflies and moths as caterpillars.

NOTE.—The term "nymph" is generally applied to the second stage of such insects as do not undergo complete metamorphosis; in such cases the young usually resemble the adult; they are smaller, however, and wingless.

Insects in an Aquarium.—Get a large glass globe from a druggist or get a glass box or globe for the purpose from a store where entomological supplies are kept. Put a few inches of sand in the bottom. Plant in the sand weeds and moss that grow in water; then sprinkle some fine gravel over the sand and among the plants. Fill the globe or box almost full of water.

By dragging a pond with the insect sieve, specimens will be secured for the aquarium and thus a most interesting field of study for the child will be provided.

Frogs and fish thrive well in an insect aquarium. Frogs' eggs or the tadpoles can easily be obtained. To watch the development of the tadpole is a most delightful study. Goldfish are very beautiful and easily fed; their food can be obtained at almost any drug store.

SUB-CLASSES OF INSECTS.

There is no little thing in Nature; in a raindrop's compass lie a planet's elements.—*Aldrich*.

The *insecta* contains three sub-classes, viz.:—

(*a*) *The Hexapoda*—true insects (bees, butterflies, beetles, etc).

(*b*) *The Arachnida*—not true insects, though having certain characteristics common with true insects (spiders).

(*c*) *The Myriapoda* (centipedes, scorpions).

Insect comes from two Latin words, "in," into, and "secare," to cut. True insects have their bodies divided into three parts, viz., the head, thorax and abdomen. The thorax has three sub-divisions, each bearing a pair of legs, while each of the two posterior segments usually bears a pair of wings, though many insects are wingless. The abdomen has nine or more ringed divisions and small openings, called spiracles, through which the insect breathes. The blood is white and cold. The eyes are compound. Some have also secondary eyes, called ocelli or single eyes. The metamorphoses are more

or less complete, the typical stages being the egg, th
larva (*larva*, a mask), the pupa (*pupa*, a doll), and th
imago (*imago*, an image). Generally speaking, the larv
condition lasts from two to six weeks, but there a
many exceptions. The wire-worm and the white gru
remain in this condition for a year or longer, whi
there are other species of larva that remain for sever
years. The pupal stage is really the resting time of th
insect. This condition, if entered upon in the summe
usually lasts from two to three weeks. If entered upo
in the fall of the year, it usually lasts till the followin
spring.

When the young caterpillar or larva comes out of th
egg, its body is more or less elongated and cylindrica
It is made up of a usually distinct head and twelve bod
segments or rings. Three of these segments form th
thorax; the remaining nine form the *abdomen*. Generall
a larva has six simple eyes, a pair of solid, horny man
dibles, which it uses to bite its food, and a spinnin
apparatus in the middle of its under lip. On the thora
and abdomen are the spiracles; also the legs and variou
other appendages.

Most larvæ have six jointed legs. In addition t
these, some larvæ are furnished with from one to fiv
pairs of soft appendages, called prolegs.

The members of the second sub-division differ from
true insects by having eight legs and other characteristic
which are not marks of the true insects.

Different Orders of Insects.

I. **Coleoptera** (*koleos*, a sheath; *pteron*, a wing).

The members of this order have a hard shell-like covering of the head, thorax and abdomen. The upper wings are horny; the under ones membranous. They have scissors-like mandibles and a masticatory mouth. The metamorphosis is complete.

The order consists of the beetles.

Among the common examples suitable for study are the may-beetle, common whirling-beetle, stag-beetle, lady-bird, St. John's-beetle (glow-worm) and potato-beetle.

II. Orthoptera (*orthos*, straight; *pteron*, a wing).

These are straight-winged insects having four wings; the anterior pair is small and narrow and cover the posterior pair, which fold like a fan and are membranous. The legs are fitted in some for running; in others, for leaping. The mouth is masticatory. The metamorphosis is partial.

The order includes crickets, grasshoppers and cockroaches.

The following examples are suitable for study:—House-cricket, cockroach, grasshopper, walking-stick and katydid.

III. Hymenoptera (*hymen*, a membrane; *pteron*, a wing).

These are membranous-winged insects with four transparent wings. The females have usually piercers or stings. The mouth is partly masticatory and partly suctorial. The metamorphosis is complete.

The order includes bees, wasps and ants.

Common examples for study are the honey-bee, wasp, ant and ichneumon.

IV. Neuroptera (*neuron*, a nerve; *pteron*, a wing).

These have four membranous wings furnished with numerous veins. They have both primary and secondary eyes. The mouth is masticatory. Their food consists of insects and flesh. In some cases the metamorphosis is complete; in others, incomplete.

The order includes ant-lions and aphis-lions.

Common examples suitable for study are the dragon-fly and lace-wing (aphis-lion).

V. Hemiptera (*hemi*, half; *pteron*, a wing).

Some of the suborders are double-winged insects a some are wingless. The proboscis is folded along breast when not in use. The mouth is suctorial. T metamorphosis is partial.

The order includes bugs, lice and aphids.

Examples for study are the giant water-bug (electr light bug), plant-lice and cicada.

VI. Lepidoptera (*lepis*, a scale; *pteron*, a wing).

The members of this order have four cuticular win covered with scaly dust. In the perfect form they ha suctorial mouths. The metamorphosis is complet These are most attractive insects.

The order includes butterflies, skippers and moths.

The following examples are suitable for study:—Cal bage-butterfly, polyphemus-moth or American silk-worn white-miller, cecropia-moth, milkweed-butterfly, tinea c fur-moth, tent-caterpillar, codling-moth, agrotis-moth— the larva of which is the cut-worm, owlet-moths—th larva of one of which is the army-worm, Isabella-mot —the caterpillar is the yellow woolly bear, sphinx-mot —the larva of one kind of sphinx-moth is the tomato worm, and the apple-leaf miner.

Butterflies have thread-like antennæ, with knobs o enlarged tips, while the antennæ of moths are of variou shapes, terminating in more or less acute tips.

VII. Diptera (*dis*, two; *pteron*, a wing).

The members of this order have two wings; the mouth- parts are suctorial. The metamorphosis is complete.

This order includes the flies.

The following examples are suitable for study:— Mosquito, house-fly and syrphus-fly.

The classification of the different orders of insects as noted above is based upon the wings. In sub-dividing

the orders into families, the number and arrangements of the veins of the wings are taken into account.

The following classification is based on the fact that some insects are useful and some injurious to man :—

(*a*) Insects that are useful.

(*b*) Insects that are injurious.

(*c*) Insects that are neutral, neither useful nor injurious.

The following useful insects should be specially observed, also the particular kind of service they give and how they give it :—

(*a*) *Honey*-loving and *Pollen*-conveying insects—bees and wasps.

(*b*) *Predaceous* insects — lady-beetles, tiger-beetles, ground-beetles, robber-flies, syrphus-flies, ant-lions, aphis-lions, soldier-bugs.

(*c*) *Parasitic* insects—

1. *Ichneumon-flies*—Parasitic upon caterpillars.

2. *Tachina-flies*—Parasitic upon larvæ of moths, upon beetles, crickets and grasshoppers.

Give pupils directions to aid them in observing the following economic insects, and the special way in which each class injures its host :—

(*a*) Cut-worms.

(*b*) Tent-caterpillars, cabbage-moth larvæ, potato-beetles, "tomato-worms."

(*c*) Codling-moth larvæ, plum-curculio.

(*d*) Maple-borers, apple-tree borers.

(*e*) Pea-weevil.

(*f*) Clothes-moths, buffalo carpet-beetles.

(*g*) Squash-bug, scale-insects, plant-lice.

For the purposes of remedial treatment, teach the importance of knowing the general form of the insect's mouth. Any and all kinds of insects can be destroyed

by dusting them with poisonous powder fine enough t enter their respiratory passages. An emulsion of coal-o or a solution of strong soap that will penetrate the bodies is an efficient method of killing insects wit suctorial mouths, plant-lice for example. Poisonou gases are effective where these can be applied. Th most convenient way of destroying insects with biting mouths, such as the tent-caterpillar or the potato-beetle is to sprinkle their food with poison either in solution o in fine powder.

NOTES ON INSECTS.

BEETLES.

Covering.—The covering is a horny case or coat of armor. Oftentimes it is marked with many beautiful colors—black, brown, gold, red and green.

Thorax.—The thorax consists of three segments. The front one bears a pair of jointed legs; the second, a pair of wings and a second pair of legs; the third, the second pair of wings and the third pair of legs.

POTATO-BEETLE.
(*a*) Eggs; (*b*) Grubs; (*c*) Pupa; (*d*) Adults; (*e*) Wing-Cover; (*f*) Leg.

Wings.—The fore-wings form a hard case over the true wings and fit closely over the back; these are not used for flying but for protection. During flight they are spread at right angles to the body. The covers of some beetles are shorter than the body.

Underwings.—The second pair of wings are very fine and silken and are neatly folded beneath the covers when not in use.

Feet and Legs.—These are hairy and do not spread out so far as those of flies or spiders.

Head.—Upon the head are a pair of antennæ, a pair of compound eyes, and the mouth-parts.

Mouth.—The mouth-parts consist of an upper lip, or *labrum*, a pair of mandibles which are fitted either for seizing or for gnawing, a pair of assistant jaws, or *maxillæ* and the lower lip, or *labium*.

Eggs.—Different kinds of beetles place their eggs in different places. They are placed in water, in the bodies of dead animals, in holes in trees, etc.

Larva.—The larva is a white grub, with scaly head and toothed mandibles. The larvæ of the different kinds closely resemble each other.

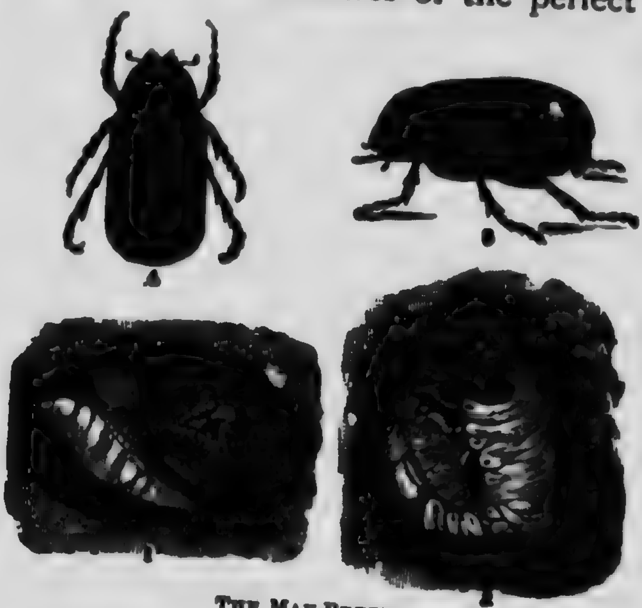
Pupa.—The legs are folded over the front of the body; the wings are packed into its sides; the jaws and feelers are laid on the breast.

There are many kinds of beetles, as the rose-beetle which lives on rose-bushes and flowers, the sexton-beetle which buries decaying animals, the whirling-beetle which whirls round and round in water.

MAY-BEETLE.

Imago.—An inch long. This is a large, plump, brown beetle. During late May and early June, it may be found buzzing about on almost any warm evening. It feeds upon leaves of the cherry, plum, strawberry, etc.

Pupa.—This is found in the ground and is fat ar strong, and shows the features of the perfect insect.



THE MAY-BEETLE.
1—Pupa. 3—Female.
2—Larva. 4—Male. (*Riley.*)

Larva.—This is a large, soft, white grub, which takes three years to develop, and is found in gardens and pastures. Sometimes it is very destructive in strawberry patches. It is about an inch and a half long.

Eggs.—These are laid at the roots of grasses and weeds.

GRASSHOPPER.

There are a great many species of grasshoppers, but they may all be grouped into two families—the acrididæ (short-horned-grasshopper) and the locustidæ (long-horned-grasshopper). The most common species in Ontario is the red-legged-grasshopper (*melanoplus femur-rubrum*) or the locust, a name properly applicable only to the "short-horned" grasshoppers. The grasshopper belongs to one of the straight-winged families of the order Orthoptera, so called because they do not fold their wings crosswise. The families

of this order are sometimes classified as runners, graspers, walkers, jumpers. The grasshopper is one of the jumpers.

THE LOCUST.

Head.—There is a knob on the forehead. Between the eyes are the feelers. The mouth is large, the jaws strong, and the eyes prominent.

Color.—The common locust is brownish grey; some grasshoppers are green or the color of the leaf they live upon. Their color seems to change in flying.

Thorax.—T[illegible] upper side of the first segment is shaped like [illegible]ge, horny collar.

Legs.—The [illegible] pair are shorter than the others; the hind pair are more than twice as long as the front pair. The thigh is strong and long; it enables this insect to jump a comparatively long distance. Between the foot and the thigh the leg has points like teeth. The feet have four parts.

Wings.—The upper pair or wing-covers are large and long; they lap at the tips and are high in the middle. When shut, the upper ones overlap the lower ones. Under the wing-covers the hind wings are laid in plaits. The most common species of grasshopper, or locust, in Ontario, makes its notes by vibrating its wing-cover upon its spiny hind leg. In most of the "long horns" the vibrations are caused by the combined action of the upper and under wings.

Food.—Vegetables, leaves of young fruit-trees, grasses; sometimes animal food is eaten.

ORDER ORTHOPTERA—GRASSHOPPER.

Eggs.—The female deposits its eggs in holes made in the ground by means of its ovipositors. They are surrounded by a frothy mucus which hardens and serves as a protection against moisture. The eggs are laid in masses in the fall of the year and are hatched during the following spring or early summer.

Nymph.—In the following spring the nymph is hatched. It resembles the adult insect in appearance, but is wingless. It moults several times and the wings gradually develop. With the last moult, it becomes a perfect grasshopper.

CRICKET.

Body.—The body is not so slender as that of the grasshopper; it is short and thick. Its color is dark glossy brown, almost black. Behind the body is a pair of long, stiff tail-hairs which look like feelers.

Head.—The eyes are large and round. The feelers are longer than the body. The jaws are strong and the tongue thick and rough.

Wings.—The under wings are larger than the wing-cases. When folded, they reach out beyond the covers of the body; where the wing-covers of the male join the body is a thin drum-head; on these drums it makes music. Beside these drums, three strong veins are under the left wing-cover; the largest is rough like a file. The sound given out, the cricket's song, is made by drawing this vein across the right wing, causing all the covers to vibrate.

Legs.—The hind legs are long and fitted for jumping. On each of the fore-legs is an oval opening with a thin membrane stretched across the bottom of the depression. This is the organ of hearing.

Eggs.—The eggs are laid in a hole in the ground about half an inch below the surface. They are fastened to each other and to the ground by glue. About three hundred are laid each year.

Nymph.—The nymph resembles the adult in general appearance. It is wingless and moults several times before maturing. The cricket is a cousin to the grass-hopper. There are different kinds of crickets, as the house-crickets, the field-crickets. Unless in a warm house, it becomes torpid in winter. Its food is vegetables, crumbs, soft grease, meat, insects, leather, woollen cloth. It is very fond of moisture and drinks liquids of almost any kind.

ANTS.

Body.—The body consists of a head, thorax and abdomen

Head.—The eyes are large. There is one on each side and a little one on the top of the head.

Mouth.—There are mandibles, or sharp-cutting teeth and a maxilla with feelers.

Thorax.—On the thorax are six legs; the six fee[t] have fine hairs.

Abdomen.—The abdomen is made fast to the thora[x] by a small joint or thread.

Wings.—The wings are set on the upper side of th[e] middle part; the upper wings are larger than the lowe[r] ones and fold back over them when at rest; in flying the upper wings hook fast to the lower ones.

ORDER HYMENOPTERA—ANTS.

Its Home.—The floors and walls of its home are pressed to keep them hard. Sometimes they are lined with a sticky sort of glue or varnish to keep the earth from falling in. There are three kinds of ants in each home, viz.: (1) queen ants, (2) drones, (3) workers, including builders, nurses, servants, soldiers. If too many ants are in a home they swarm and form a new home. The queen selects the home, then she bites off her wings and begins to lay eggs.

Queen Ants.—These are the mothers of the ant colonies. Their bodies are round and dark and have wings and stings.

Drones.—The male ants do no work; have no stings; have wings.

Workers.—Their bodies are dark; there are two sizes of them; they have neither stings nor wings.

Larvæ.—Ants dig holes two or three inches in the ground, then make kinds of halls and cells of them. The queen lays her eggs in a cell. The larvæ, small white grubs, are kept clean and fed by the nurses.

Pupa.—The larval-case is a fine net, resembling a little white bundle. The cases are of three different sizes, the largest for the "queen," the next two sizes for "drones" and "workers." The food of ants is honey, sugar, etc. They suck up the food with their rough tongues and press out the oil and juice with their jaws. They store away food for winter. In very cold weather they are torpid. There are many different species of ants, as mound-building ants, carpenter-ants, slave-maker ants.

DRAGON-FLY.

Several names are applied to this beautiful insect. It is called flying-flower because of its shape, color, and lovely motion. It is called little-lady because it is so neat, graceful, delicate and pretty. It is also called air-jewel because its wings and body flash and shine like precious gems.

Male Dragon-Fly.

The following inappropriate names are often applied to it: horse-stinger, darning-needle, spindle.

This beautiful, harmless creature lives two lives, each of which, unlike the two lives lived by many other insects, seems complete in itself, and each of which it seems to enjoy equally well. The first life is that under water and includes the egg, the larval and the pupal stages. The second is that in the air, the insect being now known by one or another of the names mentioned above.

Eggs.—The egg is dropped into the water by th mother, or deposited in the stem of a water-plant. Coo still, shallow water in a sunshiny place where plenty c water-plants grow, is generally selected. The egg i water-proof.

When the egg is hatched the larva is rather slow o lazy. It is gray, has six legs and feeds on beetles grubs, leeches, shrimps It waits patiently for its prey at the bottom of the pond or in the shadow of a leaf, or, perhaps on the stem of a leaf under water.

Female Dragon-Fly.

If prey passes within reach, it darts forward a singular jointed arm. This arm represents the under lip. It is called "the mask," and is provided with strong jagged pincers or nippers. When not in use, the mask is folded neatly under the throat of the larva.

Pupa.—The pupa is more lively than the larva. It has six legs; each foot has strong hooks. Its case is horny, pale brown, clear and shining. On some rings of the body there are horny spikes. Upon the chest is the pattern of the wings. The head and body are thicker than in the fully-developed fly.

When about ready to come out of the pupa-case, it comes up near to the top of the water. It seems tired and longs, apparently, for sun and air. It loses its fierce appetite; it breathes slowly. It seeks a stem or tall reed, creeps slowly up it and hooks its feet firmly to it. When possible it gets between two reeds and hooks a foot to each, the body being between them. It twists and pulls—head, legs, wings and long body come forth as the pupa-case splits. It hangs on a reed to rest.

In about fifteen minutes it lets go its hold and flies away, leaving its old dress attached to the reed by the claws.

Its head is conspicuously large. Its body is long and of a bright hue. It has six legs and four wings. Its eyes are exceedingly bright and flash like jewels. It is

Nymph seizing its prey by its extended lower lip. DRAGON-FLY. Imago emerging from pupa.

strong, active and hungry. It needs no net for seizing its prey now, it flies so quickly. When flying its wings show spots and lines of bright color.

The dragon-fly feeds on beetles, spiders, flies, and other kinds of insects.

GIANT WATER-BUG.

Bug.—This is a brown bug, with boat-shaped body and leathery wings overlapping each other on the back. It is the largest insect found in our fresh-water ponds.

It is also frequently found under electric lights; this reason it frequently gets the name electric-li bug.

Legs.—The legs are fitted for aquatic life, havi fringes along the sides for swimming. They are th and also fitted for grasping and clasping victims. the front leg is a longitudinal groove for the recepti of the next joint; this is a distinctive mark of t insect.

GIANT WATER-BUG.
(*Belostoma Americanum.*)

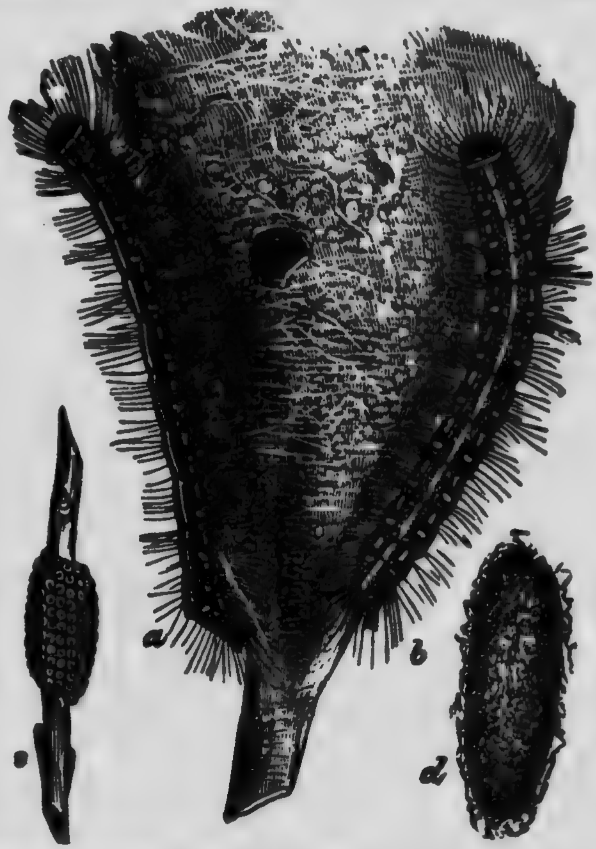
Beak.—The beak is short, powerful and dagger-lik It serves a double purpose—to strike prey and to e tract the juices from it. It is supposed to have a poiso gland.

Eggs.—The eggs are deposited in clusters of fro forty to sixty, in pieces of wood or reeds along th margin of ponds. They are about one-fifth of an inc long; are of a brown color, spotted with black, and a darker above than below. There is a whitish crescen near the top, with a black spot at the apex. The larv crawls into water as soon as it is hatched and feeds o aquatic insects.

Nymph.—It probably remains about a year in th nymph stage. It has no wings; otherwise it resemble the adult. When ready to emerge, the skin splits dow the back and the perfect insect appears. These bugs ca easily be studied by keeping them in a vessel of wate

APPLE-TREE TENT-CATERPILLAR.

Moth.—The moth is reddish brown. Its front wings are crossed by two oblique, parallel, white lines. When fully expanded, the wings are from one and a half to one and three-quarters inches across. The hollow tube with which butterflies and moths suck up food is wanting; hence the moth has no power to take food. It



(*a*) The Caterpillar; (*b*) The Caterpillar; (*c*) Eggs; (*d*) Cocoon.

remains at rest and in concealment during the day, but is very active at night. It is attracted by a glare of light; which generally bewilders it.

Eggs.—The eggs are laid about the middle of July upon twigs about the size of a lead-pencil. They are

placed side by side round the twig, in clusters of f two hundred to three hundred. They are then cove with a thick coat of tough varnish, which renders th water-proof. In shape each egg is cylindrical.

Caterpillar.—The caterpillar is fully matured in egg, but remains in a torpid state till spring. It gen ally emerges about April. Its first meal is taken fr the gummy substance that was upon the eggs; then begins to feast greedily upon the young buds. T apple and the cherry are its favorite trees. It reac maturity in about six weeks; and is then about t inches long. The black body is covered with hairs white stripe with yellow longitudinal lines on each s runs down the back. On the sides are also spots a streaks of pale blue.

Web.—Shortly after they are hatched, these te makers extend a sheet of silken web across the near large fork of the twig upon which they were hatch As they increase in size they enlarge their tents. Wh completed the tent is generally from eight to ten inch in diameter. The entrance is at the angle of the fork.

Into this tent the caterpillars retire during the night a in stormy weather. They also rest in it during the da They leave it regularly, however, in the daytime, on during the forenoon and once during the afternoon, search of food. In order not to lose their way home, ea caterpillar spins a silken thread after it wherever goes. When young, they may often be seen crawlin from place to place in single file in close procession.

Cocoon.—The cocoon is a double web; the outer cove ing is closely woven and filled with a powdery substan like sulphur. It is generally hid in such out-of-the-wa places as under rails, boards or rubbish. Within the cocoons the tent-caterpillars change to chrysalids of brown color. In about two or three weeks the mot escapes.

FOREST TENT-CATERPILLAR.

This insect bears a close resemblance to the apple-tree species. Along the back of this species, however, is a row of diamond-shaped white spots. These spots serve to distinguish it from the other species. The forest tent-caterpillar is a general feeder, but shows special fondness for the maple, the basswood, and the poplar. The eggs of this species are also laid in large clusters which are squarely cut off at the ends. The cocoons have none of the powdery substance of the apple-tree species and are often found within the leaves hanging to the trees. The tent of this species is spun against the side or branches of the tree upon which they are hatched.

MILKWEED OR MONARCH BUTTERFLY.

This butterfly is truly a beautiful creature when seen floating majestically in the summer air. It is usually called the milkweed-butterfly, and is very common dur-

ing the whole summer. It cannot, however, survive the winter in any stage of its existence, either in Ontario or farther north. The life-history of this insect has not, as yet, been fully ascertained. Of one fact, however,

scientists are certain, that is, that it migrates late in autumn in immense numbers and returns in the spr Dr. Scudder says that the milkweed-butterfly belong a tropical group of insects, and that it is long-lived. female starting northward, he says, may deposit eggs as she goes, a few at a time, until she reaches northern limit of her food-plant, the milkweed.

The milkweed-butterflies which are hatched in north lay eggs the same season. These insects h wonderful power for sustaining flight. Individuals h been seen at sea hundreds of miles from land, while the north, dozens have been seen during the even hanging to heads of grain or huddling together in gr numbers on the dead branch of a tree, looking like li triangular brown leaves upon it. These had come sin and in rapid succession, for during the day they had flo about alone, seemingly without aim, and caring little the company of one another.

This butterfly is one of the many insects that do injury to cultivated plants.

CODLING MOTH.

Moth.—This is a pretty, tiny moth, with velvety bo and wings, resembling grey and brown watered silk. appears only at night. It conceals itself during t daytime. It is not attracted by the light. There a two broods during the season.

Eggs.—Each moth lays about fifty small, yellow eg Those for the first brood are deposited in the blossom the apple, just in the calyx or eye where the you apple is forming. The eggs hatch in a week. The lar crawls into the young apple to the core. Castings a thrown out through the entrance place.

Larvæ.—The larvæ are fully grown in from three four weeks. The head is black; the body, flesh-colore On the body are minute elevated points, a fine hair pr truding from each point. When ready to escape the

frequently make a new passage through the apple. They let themselves down the branches and trunk of the tree by silken threads, if their apple-home does not drop to the ground. Then they creep into crevices or under the rough bark of the stem to spin a cocoon.

Cocoon.—The cocoon is a papery-looking silken case attached to the walls of the crevice or the bark by threads and concealed by small bits of bark. In three

(*a*) Channel made by larva; (*b*) Exit from channel; (*c*) Larva; (*d*) Chrysalis; (*e*) Cocoon; (*f*) Moth; (*g*) Moth; (*h*) Head of moth enlarged.

days or thereabouts, a chrysalis containing the pupa forms. In two weeks afterwards, the pretty moth emerges.

The second brood are on the wing about the end of July. A little later they deposit their eggs. The larvæ mature in late autumn or early winter. They spin cocoons and remain in the larval state concealed in them till the following spring. About the time of the blooming of the apple-tree, the moths appear.

POLYPHEMUS MOTH.

This insect is known as the American silk-wor Its cocoon usually drops to the ground with the fall the leaves, and remains there during winter. Late May or early in June this beautiful insect escapes fro its prison-cell. It flies only at night.

Larva.—When full grown this is three inches lon and has a very ' ck body. It is yellowish green, rath pale, with seven oblique, pale-yellow lines on each sid of the body.

Segments.—Between the segments of the body ar spaces deeply indented. Each segment is adorned wit

a tubercle, at times tinted orange. In the middle of each segment is a silvery spot, with a few hairs arising from it. The terminal segment is bordered by an angular band of purplish-brown color.

Head.—This is pale brown.

The larva feeds on the leaves of the plum, the oak the hickory, the basswood, the walnut, the maple, the butternut and the hazel.

Cocoon.—The cocoon is a tough pod-like enclosure of a brownish-white color. Within the cocoon, the larva changes to a chrysalis of chestnut-brown color.

Wings of Moth.—These are from five to six inches across when expanded and are slightly wider in the male. They are ochre, yellow or rich buff, often tending towards pale grey or cream in color. At times they approach a light brown; towards the base they are crossed by irregular, pale white bands, margined with red. Their outer margin has a strip of pale purplish white, bordered with brown of a deep rich color.

CATERPILLAR OF POLYPHEMUS MOTH.

COCOON OF POLYPHEMUS MOTH.

Spots on Wings.—These are transparent; they are eye-like and are crossed by slender lines. The front spots are margined with yellow and edged with black. The back spots are bordered with yellow and edged above with a line of black and blue. The spots are a little different in shape and markings in the male.

Antennæ.—These are feathered in both sexes, but are wider in the male.

Eggs.—The eggs are deposited on the underside of a leaf. Usually there is only one on a leaf; occasionally two or even three have been found.

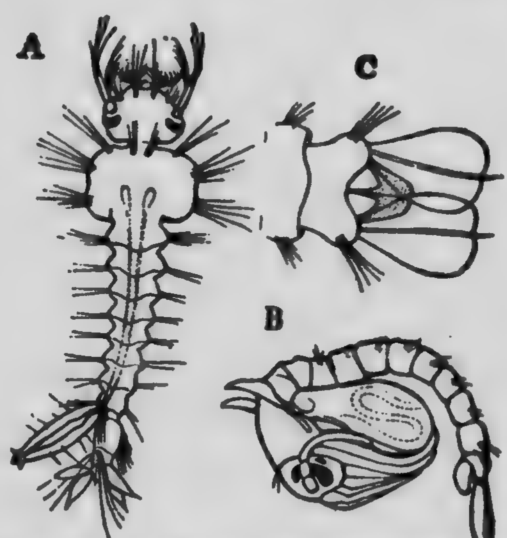
MOSQUITO.

To those who are curious to know the wonders of Nature, there is no more interesting study than the mosquito. A barrel or a bucket of water, if left standing for a few weeks in warm weather, will afford ample opportunity.

Body.—The body is long and cylindrical.

Wings.—These are generally crossed when in repose; they appear very beautiful when seen through a microscope and are covered with scales.

Antennæ.—The antennæ of the males are fine and feathery.



(A) Full-grown larva. (B) Pupa. (C) Anal segment. *(Howard.)*

Eyes.—The eyes are very large, covering nearly the whole head. They are brilliant and at times change color.

Proboscis.—This is the instrument used for puncturing the skin of its victims. It is a cylindrical case covered with scales. It contains the sting.

Sting.—The sting is really a miniature sword. The wounds made by the sting are impregnated with an irritating fluid which exudes from the proboscis.

Larvæ.—These are found in stagnant water. They are very small. They come to the surface of the water to breathe. The breathing pipe is attached to the abdominal segment next to the last. In some species the body hangs down when breathing; in others, it is nearly horizontal. The digestive tube ends in the orifice of a short tube at the right of the last segment.

Abdomen.—There are tufts of hair on each segment.

Thorax.—There are three tufts of hair on each side.

Head.—Round the mouth are wattles furnished with hairy-like filaments. These move quickly and cause tiny currents of water to flow to the mouth of the larva. This water contains microscopic insects and particles of vegetable and earthy matter.

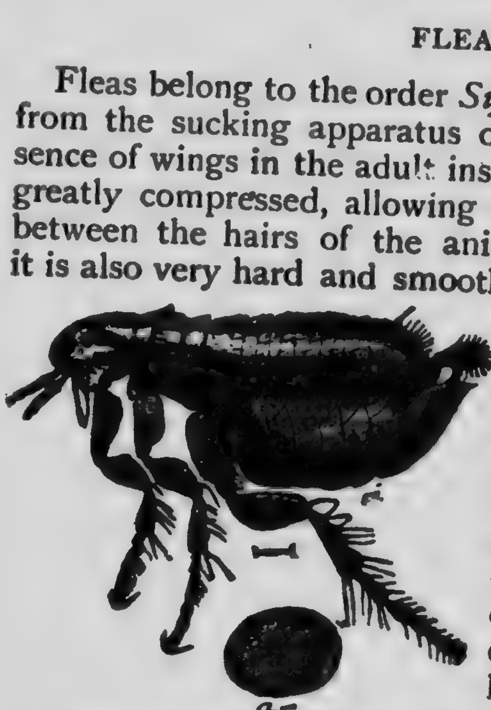
Pupa.—When the larva has changed its skin for the fourth time, it becomes a pupa. It does this in three weeks.

Body of Pupa.—The body of the insect is now shortened and rounded. The pupa does not eat in this condition, but moves and swims. It is now as necessary as ever for it to breathe air. The first breathing apparatus was lost when the skin was shed. It now breathes through the two ear-like appendages on the head. It develops little by little. Its principal members can be seen under the transparent skin which envelops them. It comes to the surface of the water when ready to change again; raises its thorax above the surface and straightens its body. The skin then splits between the breathing tubes and down the back, and the perfect insect emerges.

Eggs.—A few days after the insect enjoys its liberty, it deposits its eggs on the surface of the water. Many generations are born in a single year, each generation requiring from three weeks to a month to bring forth a new generation.

FLEAS.

Fleas belong to the order *Siphonaptera*, a name derived from the sucking apparatus of the mouth and the absence of wings in the adult insect. The body is oval and greatly compressed, allowing the insect to move freely between the hairs of the animal upon which it lives; it is also very hard and smooth, enabling it to slip away from between the fingers of its captor or the teeth of a dog. Its escape is also facilitated by its long and powerful legs, which enable it to leap an immense distance when compared with the size of its small body. Its eggs are laid between the hairs of the infested animal, but are not fastened to them, so that when the animal moves about or lies down, they are shaken off. The larvæ, which are very minute and rarely seen, except by those who search for them, live upon animal and vegetable matter contained in the dust to be found in the cracks of floors or the sleeping-places of animals. The frequent sweeping and scrubbing of rooms is, no doubt, an effectual preventive of their development.



ADULT FLEA; (a) egg—(enlarged).

Remedies.—Should a dog or a cat be found to be infested with fleas, it should be thoroughly washed with a carbolic soap or dusted with insect-powder, and its sleeping-place turned out and cleaned. Any bedding it has lain upon should be burnt and fresh material, such as straw or shavings, should be supplied and frequently renewed. The kennel should also be washed inside with some coal-oil or benzine. If any rooms in a house are infested, the carpets or rugs should be taken up and thoroughly beaten and shaken out of doors and the floor scrubbed with hot soapy water.

SPIDER.

The spider is not a true insect. Its body is in two parts. The head and thorax are united in what is called a cephalo-thorax. The front part of the body is always smaller than the hind part. It is to this part that the eight seven-jointed legs are attached. Each of the legs of the spider terminates with three toothed claws or with two claws and a brush.

DIFFERENT TYPES OF SPIDERS.

Projecting from the head are two six-jointed palpi which are so large that they might be mistaken for a pair of legs. Between the palpi, are toothed mandibles furnished with fangs connected with a poison-gland. Behind the mandibles on the under side, are the maxillæ or chewing organs. The eyes are two, four, six or eight in number and are variously but always symmetrically arranged.

The spinning organs are situated near the hind part of the body. They consist of a number of glands and tubes connected with them. The glands are in six clusters called spinnerets. In spinning, the threads from all the tubes unite. The thread thus formed is, how-

ever, finer than the finest silk. Spiders are especially adapted for either leaping, binding, seizing or weaving.

Spiders that spin webs make three divisions in them—the web proper, the nest, the snare-line. Webs are of various shapes, as circular, triangular, somewhat oblong. When the spider wishes to spin its web, it presses the end of its spinning-tube. It makes a drop of glue fast to a wall, leaf or stem. It then moves or falls away. As it goes, the glue spins out in fine streams. These unite in one and turn to silk-like threads. In circular webs, the rays are spun first, the spider guiding the line with its feet and pulling it to see that it is strong. It then spins a thread round and round from ray to ray till the work is done. It puts a drop of glue where the silk thread crosses the ray line.

A spider's nest, generally speaking, is of close, fine silk. It is ball-shaped, basket-shaped or horn-shaped. In this silken nest it lays its eggs. The nest is built near the web, but attached to it by a long line, the snare-line. If prey gets in the web, this line will shake. The spider runs up the snare-line, kills the prey, winds fine thread around it and carries it to its nest.

Spiders are very clean. They dislike dirt. They frequently shake off the dust of their webs with their feet. If dirt of any kind sticks to the web, they will bite the piece out and put a new piece in.

In spring, the young spiders come out of the silken ball in which the eggs are left all winter. From babyhood to maturity, the spider molts its skin several times. The new skin is fine and soft, but it soon grows tough.

There are many different kinds of spiders—the domestic spider, which spins the webs in the corners of rooms; the weaver, that weaves the beautiful geometric web; the trap-door spider, that forms tunnels in the earth; the gossamer spider, that forms a closely-woven web which it spreads horizontally over the surface of the ground. The latter webs are very pretty in early morning when sparkling with dew.

CHAPTER IV.

FISH.

I love thy rivers, broad and free—
Thy cataracts sublime,
Where God unveils His majesty—
Whose hymns make grandest melody,
That strikes the ear of Time.
—*E. H. Dewart, D.D.,* "*God Bless Canada.*"

The study of fish may, if the teacher so desires, be introduced to the child before that of birds or flowers. If specimens are kept alive in an aquarium and if the child is given the privilege of watching them from day to day, the subject becomes one of great interest.

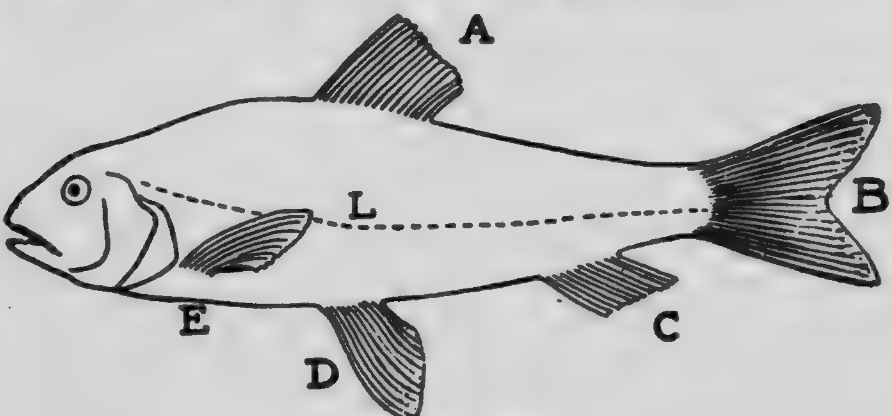


DIAGRAM OF A FISH.

A—Dorsal Fin.
B—Caudal Fin.
C—Anal Fin.
D—Pelvic Fin.
E—Pectoral Fin.
L—Lateral Line.

1. Direct the observation of the child in such a way that his attention will be drawn to the easy, noiseless, graceful movements of the fish.

2. Though fish may vary in shape and size, their general shape is especially adapted for cutting through the water.

(*a*) *Head.*—The head is sharp and wedge-shaped. It serves, like the prow of a boat, to divide the water.

(*b*) *Body.*—The body is long, narrow and smoot The scales overlap each other, the free edges bein always away from the head.

(*c*) *Tail.*—The tail, as it bends from side to sid pushes the fish along and guides it in its course. I the latter respect, it acts much in the same way as th rudder of a boat.

(*d*) *Fins.*—The fins act both as ba.ancers and oars.

3. Keep the outline of a fish drawn on the blackboar and write on it the names of the different fins. In mos of our common fish there are seven fins.

(*a*) *Back or Dorsal Fin.*—Situated near the middle o the back.

(*b*) *Tail or Caudal Fin.*—At the end of the body; a broad, notched fin.

(*c*) *Anal Fin.*—A single fin situated on the ventral line of the body.

(*d*) *Pelvic Fins.*—On the under side of the fish, but not as far back as the anal fin. There are a pair of these fins, which are sometimes called the leg fins.

(*e*) *Pectoral Fins.*—Also paired; near the head, in a position corresponding to our arms.

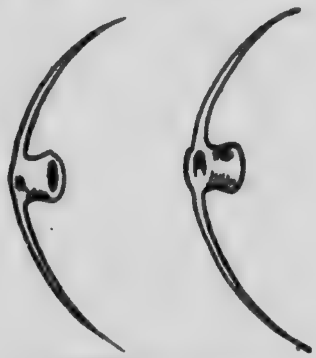
NOTE.—Draw attention also to the lateral line extending from the head to the caudal fin, a line made up of a series of small tubes which open upon the surface and serve as a sense organ.

4. *Head.*—Just above and behind the mouth are the eyes, one on each side of the head. They are not supplied with lids. A few fish that live in water into which no light penetrates are destitute of eyes. Below and back of the eyes are the gills and gill-covers. Fish take the water in at their mouths; then, by a motion like swallowing, they drive it out through the gills; the gills sift out the oxygen as it passes through them. Oxygen is necessary to the life of fish. Fish in an aquarium will die, unless the water is renewed, because of the lack of oxygen.

5. *Skeleton.*—The backbone runs from the head to the tail of the fish. It is made of little pieces of bone

shaped like cups. On each side each piece has two or more long spines like ribs. The skeleton looks something like the frame of a boat before the planks are put on.

6. *Air-bladder.*—This is a bag of air situated under the backbone. Its chief use is to enable the fish to remain in its proper position in the water. When the fish wishes to rise to the surface, it fills this bladder with air; thus the body of the fish becomes lighter, and hence it can ascend in the water with great ease. When the fish wishes to descend, it lets the air out of the bladder; it does this by contracting the strong muscles, decreasing the size of the bladder and compressing the



VERTEBRÆ OF FISH.

air or forcing it out. Turbot, sole, plaice and other fish that live at the bottom of the water have no air-bladder.

7. *Color.*—The bright color and gleam of the fish is due to its scales. Many scales are rainbow-hued. They have the gleam of many colors, according as the light strikes them. Each kind of fish has its own special color, and such colors have their special place on the fish. Much of the beauty of the fish is in the color of its scales. A herring when seen in the water has a dress of blue, green and silver. When salted, these colors all disappear. A fish, called the gurnard, has a dress of deep red and bronze, while its fins glitter with many beautiful colors.

8. *Scales.*—The scales of different fish vary in s shape and color. Generally speaking, they are ho like the finger-nail, but thinner. Their shape is gen ally rounded, or with a jagged hinder edge. The form called cycloid, are typical on lake herring. The lat called ctenoid, are typical on scale or rock bass. Th are fastened by the smaller edge to the skin of the f Each scale laps over the one next to it. They are set that they overlap from the head to the tail. T number of scales in a line is often used to distingu the species. In the middle of each scale on the late

A. B.

Two Kinds of Scales—(enlarged).
A—Lake Herring. B—Rock Bass.

or side line of the fish is a little canal or groove. runs from head to tail. This little canal contains a glu like substance which is made near the mouth of th fish. It is supplied to the scales by little tubes nea the mouth. Its use is to keep the body supple, th scales limber and healthy, and also to aid the fish i gliding easily through the water.

Some fish have no scales. Some have such tiny one as to be scarcely noticeable. Some fish, sturgeons fo example, have great bony-plates laid in lines up an down the body.

9. *Teeth.*—The mouths of most fish are hard, horny and lined with teeth. Some, however, are toothless

There are fish that have the tongue quite covered with teeth, while there are others, again, that have their teeth placed along the side of the throat. The teeth of fish are of different shapes and sizes. Much can be learned about the habits of a fish and the nature of its food by examining its teeth. Ray-fish have strong teeth for crushing their food. Fish that live on their own species or on other animal food have sharp, slight teeth that bend inward, in order to enable them to hold their food firmly. Insect-eating fish have numerous, fine, hair-like teeth, while those that feed on weeds have short, roundish ones.

10. *The Ear.*—The fish has only one part to the ear—the internal ear, or labyrinth. This is generally enclosed in a bony or cartilaginous capsule, at the end of which are small apertures. Here the auditory nerve terminates. The sound is conveyed through this labyrinth to the nerve through passages formed differently in different species of fish.

11. *Eyes.*—The eyes of fish that come to the surface of the water for food are so constructed as to enable them to see objects near them, in order that they may guard against enemies; but they are so adjustable that they may readily accommodate themselves to the thin air and the much denser water.

12. *Size.*—The tiny little minnow of the pond or brook is only about an inch long. The sturgeon is often found from twelve to fourteen feet long and weighing as many as five hundred pounds. Compare this size with that of the great shark, which has been found thirty feet long.

13. *Where Fish Live.*—(*a*) Some live in salt water; (*b*) some in fresh water; (*c*) some spend part of their lives in fresh water and part in salt water; (*d*) some can live only in very clean water; (*e*) some prefer muddy streams; (*f*) some live in icy cold water; and (*g*) others favor hot ponds or springs. Fish that live in one kind of water may be acclimatized so as to live in another kind.

14. *Habits.*—Fish often keep together and fee together. In some places you can catch, for instanc only catfish; in others, only trout. Herring are ofte found in great schools. Some fish keep near the edg of the stream; others prefer the deeper water of th middle. A pair of fish have been known to live togethe for years, while fish have been found living alone.

15. *Disposition.*—Some fish are so timid that th slightest sound will make them hide. Others, again, wil lie in plain view, or boldly follow their prey. Fish are on the whole, not really very intelligent, but those kept i aquariums and ponds learn to know those who feed them. They become great pets.

16. *Where Fish Live in Winter.*—Some fish are not unlike many of our birds and, indeed, some of our butter-flies, in regard to their habits of passing the winter. They migrate south to places where their food is abundant. Others, again, sink to the bottom of the stream or lake and remain there in a semi-dormant condition till spring; while a great many, especially the larger fish, select a place in the stream where the water is so deep that it will not freeze to the bottom. If the place at their command is sufficiently deep to prevent them from becoming chilled, they will remain active, swim about, existing, as best they can, on whatever food they are able to obtain. Should fish of this kind become chilled, they sink to the bottom, remain almost motionless, and do not even attempt to seek food.

17. *Eggs.*—Each female fish lays many thousands of eggs. They are of a pearly white color and are covered with a kind of glue so that they stick together. After the eggs are laid, they are called *spawn.*

18. *Where the Fish Lays its Eggs.*—Some kinds of fish, mackerel for example, drop thousands of eggs in the water. As they are sticky, they cling together and adhere to the sand after sinking to the bottom.

The *perch* drops her eggs in a long chain among grasses and leaves of water-plants.

The *black bass* makes a smooth bed for her eggs. This bed is generally in the shadow of a smooth stone or sunken log.

The *trout* is very careful of her eggs. The little mother selects a nice shady place in the bottom of some clean stream. She takes the pebbles out of this place with her mouth and forces the coarse sand aside with her anal fin. Here she drops her eggs and then covers them with gravel so that they will not be washed away.

19. *Time of Hatching.*—The length of time which the hatching process takes, varies much in different species. Much depends on the temperature of the water and the size of the egg. Eggs laid in October and November do not hatch till the following spring; while from eggs laid in spring, the fish generally attain, in our more common fish, their adult form in three months.

20. *Young Fish.*—Young fish are called fry. As the fish grows within the egg, the soft, skin-like case becomes very thin. The little fish breaks this case and comes out. It lives on the albumen of the egg for some time; then it becomes quite independent and goes about hunting food for itself. Many fry look like the parent fish. Others change much between their first and full-grown state.

Classes of Fish.

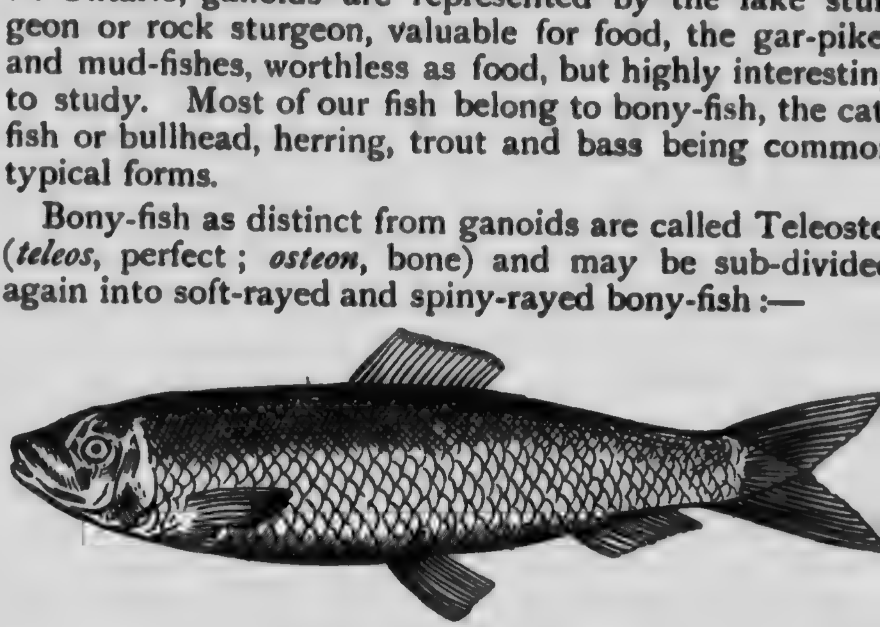
Zoologists divide fish into four sub-classes.

1. The sharks and rays.
2. Bony-fish and ganoids.
3. The chimæroids.
4. The dipnoi or lung-fish.

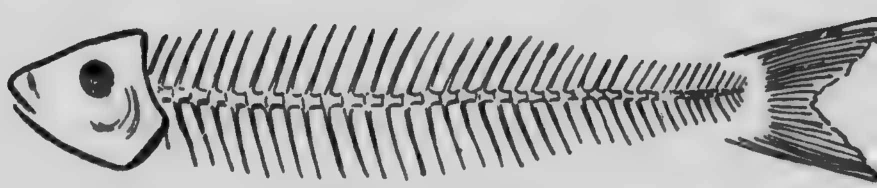
Sub-classes (1) and (3) are not represented in fresh water. Sub-class (4) was, until a short time ago, considered extinct, only fossils being found. Three genera are, however, now known to exist.

Sub-Class (2).—The name, ganoid (*ganos*, splendor), i taken from the enamelled scales which are well develope on these fish. There are few living species of this grou In Ontario, ganoids are represented by the lake stu geon or rock sturgeon, valuable for food, the gar-pike and mud-fishes, worthless as food, but highly interestin to study. Most of our fish belong to bony-fish, the cat fish or bullhead, herring, trout and bass being commo typical forms.

Bony-fish as distinct from ganoids are called Teleoste (*teleos*, perfect; *osteon*, bone) and may be sub-divide again into soft-rayed and spiny-rayed bony-fish:—



HERRING.



SKELETON OF HERRING.

I. Soft-rayed Bony-fish.—These have *soft finrays*, with the exception of one or more anterior ones which are modified into defensive spines; their scales are usually cycloid. The air-bladder opens into the alimentary canal.

(*a*) The most primitive of these are the following families: *Catfish, minnows, suckers.* Closely allied to the suckers are chub, dace, shiners and two introduced genera—the goldfish from China and the carp proper, also an Asiatic fish.

(*b*) Another natural group of this division are the *moon-eyes* or toothed herring, the *sea-herring*, and the *shad*. These fish are covered with silvery scales, usually cycloid, sometimes deciduous; the anal fin is long, the caudal one forked. The gaspereau, or alewife is one of the sea-herring introduced to fresh water. It is common in Lake Ontario. These herring are almost toothless; they have, however, very long gill-rakers. They are gregarious fish; swim in immense schools; many ascend to fresh-water streams and spawn there; some return to the ocean; others become land-locked. The abdomen is keel-shaped and has small bony plates on its lower margin. The moon-eyes have mouths crowded with teeth.

(*c*) The salmon group is by far the most important of the fresh-water teleosts. The following belong to this group:—

1. *The Whitefishes*, including the common white-fish; the long-jaw of Lake Ontario, known as the cisco in Lake Michigan; the lake herring and the Lake Ontario cisco.
2. *The Grayling*.
3. *The Salmon*, including the salt water salmon, the lake salmon and the brook and lake trout.

(*d*) *Pike Family*.—The two species common in Ontario are the common pike and the great pike, or *maskinonge*. Other fish closely related here are the *trout-perch* and *mud-minnows*.

II. Spiny-rayed Bony-fish.—These are not only marked by the absence of a duct between the air-bladder and the alimentary canal, but also by the far forward position of the ventral fin. Spines largely replace the soft rays of the dorsal and anal fins.

This group is represented in Canada by such families as the following:—

1. *The Perches*, including the pike-perch and th darters, or dwarf perches.

2. *The Sun-fishes*, including the sun-fish and black bas

3. *The Sea Bass*, including the striped bass, or rock fish and the white bass.

4. *The Sticklebacks.*

5. *The Drums.*

6. *The Cod-fishes*, including the ling, haddock, hak and cod-fish.

7. *The Mackerels.*

Study with the children the following fish:—The common catfish or bullhead, the common sun-fish, the stickleback, the black bass, the minnow, the darter, the carp, the goldfish (from aquarium).

Notes on Fish.

MINNOWS.

The minnows are a distinct group of fish. They are frequently considered undeveloped fish of different species. They are closely related to the "suckers." The chief members of the minnow group are the *red-fin* or *dace*, the *spotted shiner*, the *fall-fish* or *chub* and the *red-sided shiner*. They are of no economical value except as food for larger fishes.

The chub is commonly spoken of as "the king of the brook." It is a voracious fish. It does not hesitate if hungry, to attack fiercely and devour eagerly any tiny fish, it may come across. It lives, however, chiefly upon insects and worms.

The shiner is about the size of the chub. It has, however, much larger scales and, unlike the chub, has a humped-back appearance. This is owing to the elevation of the back in front of the dorsal fin. In spring, the lower fins of the male have a decidedly reddish cast. At other times of the year, its sides are steel-blue.

STICKLEBACKS.

Two species of sticklebacks are common in our Great Lakes—the *nine-spined stickleback* and the *five-spined stickleback*. Both these species eat the spawn of other fish. They are very voracious, and pugnacious too; hence they may be considered one of the great enemies of our more useful fish.

Few fish, however, are more interesting as a study, for there are not many so skilled in home-making or have better domestic qualities than the little stickleback. It builds a nest of weeds and grasses. These are cemented together by glandular secretions of the male. After the eggs are laid, the brave little male will defend the home with great vigor.

The body of the stickleback is slender and extremely narrow at the tail. They belong to the spiny-rayed fishes, and are of no economical value.

DARTERS.

The darters are closely related to our common yellow perch and pickerels (pike-perches), for darters are really dwarf perches that have taken to live in small and rapid streams. The largest of the species is only six inches long, while the land darter and others rarely exceed two or three inches in length. In becoming dwarfed, they seemed to have lost none of the characteristics of their ancestors. They are bright, active, and, in proportion to their size, powerful little fish. To see them as they dart about, hiding now under a stone or a leaf and then resting on or near the bottom of the stream, their heads up-stream, is, indeed, an interesting sight.

The body of a darter is compact. It tapers gradually from a short head to a narrow tail. The eyes are situated near the top of the head. The coloring of some darters is very beautiful, partaking of all the colors of the rainbow. Others, again, have a very plain ground color, broken here and there by a few brown markings.

In swimming, the darter uses his pectoral fins much more than does the average fish ; hence his power to fly, as it were, through the water.

They are an interesting and suitable fish for an aquarium.

GOLDFISH.

These beautiful little creatures are natives of China. For centuries they have been domesticated in many different countries. They vary greatly in form and coloration, but, as their name indicates, the golden cast is their distinctive mark.

CATFISH OR BULLHEAD.

The catfish is one of our most common fishes. It is not only prolific, but takes care to protect its young. For these reasons, no doubt, it may be found in almost any pool or stream during summer. Then, too, it will thrive in water too impure for fish of almost any other species ; indeed, it seems to prefer streams, the bottoms of which are muddy and weedy.

The habits and tastes of this fish are, by comparison with many other kinds of fish, lacking in refinement. The catfish moves in a lazy, sleepy manner. It enjoys food that other fish would pass in disgust. Animals, living or dead, are relished alike by it. It uses its barbels in searching for its food.

The catfish has not the ordinary scaly covering of a fish. This and his barbels are his own distinctive marks. The ears are also peculiar. They are entirely sheltered within the skull, and have no communication with the outside.

The catfish is considered by many a good food fish. It is recommended as a profitable fish for pond culture.

BLACK BASS.

There are two kinds of black bass—the large-mouthed and the small-mouthed. Though found in the same body of water they prefer and seek different surroundings. The small-mouthed bass are found in rocky streams and about gravelly shores; the large-mouthed are found in deep pools with muddy bottoms, and around sunken logs.

The food of the adult bass is crayfish, frogs, water-snakes and minnows. The food of the fry, however, is worms, tadpoles, minute larvæ and tiny young fish.

The nest of this fish is fashioned with great care and skill by the female. It is generally formed on a gravelly or sandy bottom in about two or three feet of water. It is circular in form with a diameter twice the length of the fish.

The time of spawning varies with the temperature of the region and the depth of the water in which the spawn is deposited. Shallow waters reach the suitable temperature more rapidly than do deep waters.

The hatching process requires from eight to ten days. During all this time both parents devote themselves to the protection of the nest against spawn-eaters. The fry are also most carefully protected by these fond and vigilant parents. For the three days they remain in the nest before making off for deep water, it is covered and the water in it is aerated with their fins. The fry grow rapidly, reaching maturity at the end of the second year. Their average length is then about twelve inches. The limit weight of a large-mouthed adult black bass is from six to eight pounds and of a small-mouthed one from four to five pounds.

These fish hibernate during the winter season. When possible, they bury themselves deep in the mud near a sunken log, and leave these comfortable quarters only a few weeks before spawning time, when they find their way up stream and begin home-building.

SUN-FISH.

The sun-fish and bass are members of the same family. They all show more or less of the same kind of home-making traits. The sun-fish prefers quiet streams and may be easily caught in such just about sunset any summer evening. This beautiful fish is frequently called pumpkin-seed; possibly because its thin, flat body is shaped something like a pumpkin-seed. No doubt it was dignified with the name "sun-fish" because of its brilliant colors. Its back is olive green, shaded with blue; its belly is bright yellow; its sides are spotted with orange; while a bright scarlet spot marks each side of its head.

AMPHIBIANS.

This class of animals includes frogs, toads and newts. Although not strictly aquatic they spend more or less of their existence in the water.

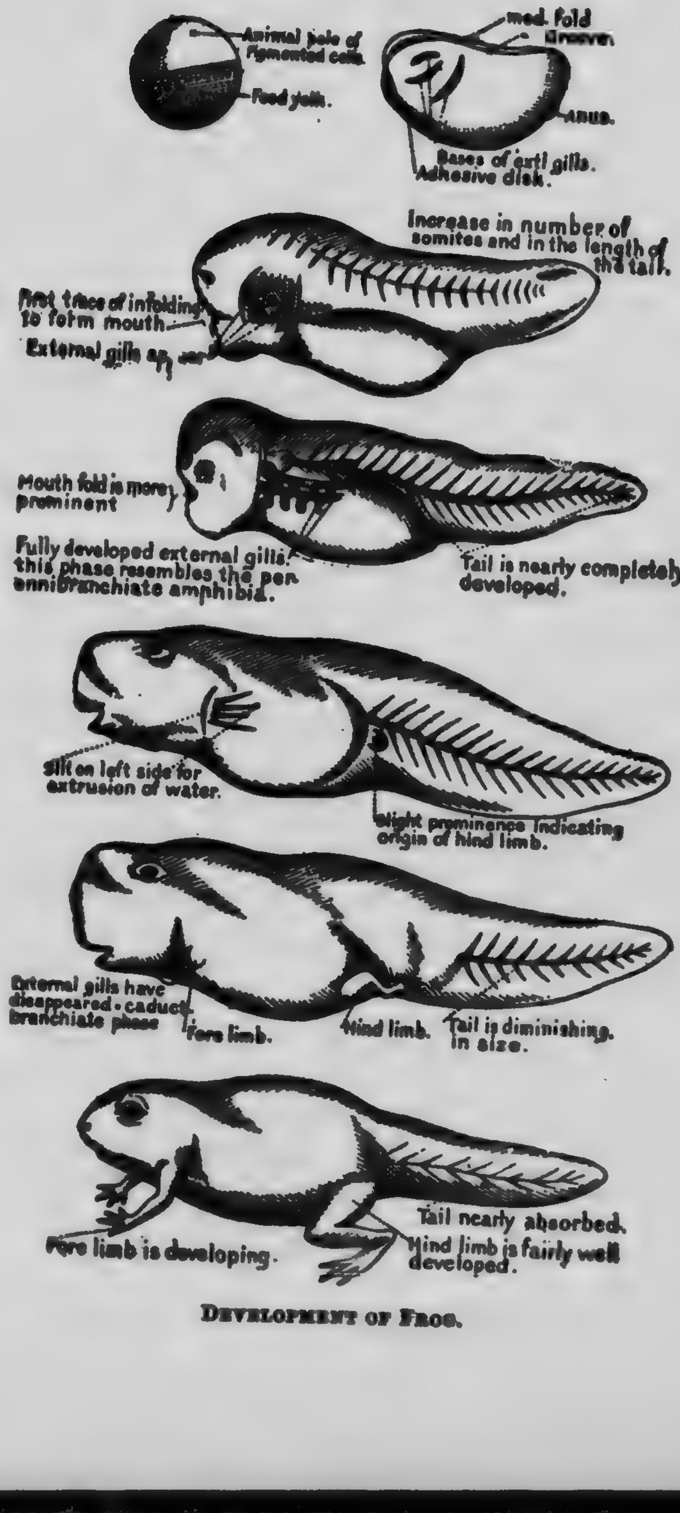
"Their life-history is as full of romance," says Furneaux, "as is that of some insects." They begin life as little fish-like creatures. The whole of their infant period is spent in the water. They breathe by means of external fringe-like gills during all this time.

While in this stage, amphibians also resemble fish in the following particulars: They have a two-chambered heart and a pair of air-sacs. These sacs correspond to the air-bladder of the fish.

As these little fish-like creatures advance in life, a series of wonderful changes takes place. They gradually lose their fish-like form and develop into creeping or jumping animals.

The external gills disappear. These give place to an internal pair hidden in clefts behind the head. These, in turn, soon give place to lungs that have been gradually evolving from the air-sacs. The two-chambered heart develops into a more complicated organ with three chambers or cavities.

Limbs have also been slowly making their appearance, first one pair, then another. The tail in some species is absorbed; in other species it develops and gives symmetry to the body.



DEVELOPMENT OF FROG.

The skeleton of the higher amphibians closely resembles that of the highest animals. The ribs, however, are either very short or entirely absent.

The blood of amphibians is cold like that of fish. It is remarkable for the large size of the blood corpuscles, which in the blood of the frog are one eight-hundredth part of an inch in diameter. With a microscope of low power the circulation of the blood can be easily observed in the web of a frog's foot.

CHAPTER V.

MINERALS.

Observations on minerals may be begun by comparison of the qualities of two or more common species; for example, water and clay, clay and chalk, mica and anthracite, mica and limestone, limestone and copper, limestone and quartz.

A cabinet of standard specimens for comparative determinations of lustre and hardness is desirable, and, although not indispensable for the purposes of nature-study, it is necessary for even elementary study of mineralogy.

The extent to which a study of minerals may be carried in a school will depend on its equipment for heating, crushing, weighing and otherwise manipulating the specimens.

The following is intended to suggest lines of investigation and points of comparison.

1. Distinguish minerals from animals and plants.

2. Make observations on the following points:—

(*a*) The sources and uses of minerals.

(*b*) Their condition, whether solid, liquid or gaseous.

(*c*) Their form, whether massive or crystalline.

(*d*) Their chemical composition.

(*e*) Their physical properties :—

(1) Related to Light—

- —Reflected—
  - —Lustre—
    - —Intensity—
      - —Splendent, as galena.
      - —Shining, as calc-spar.
      - —Glistening, as ice.
      - —Glimmering, as granulated limestone.
      - —Dull, as chalk.
    - —Quality—
      - —Metallic, as tin.
      - —Adamantine, as diamond.
      - —Vitreous, as quartz.
      - —Resinous, as garnet.
      - —Waxy, as opal.
      - —Pearly, as talc.
      - —Silky, as asbestus.
  - —Color.
  - —Streak, *i.e.*, the color of the fine powder.
- —Transmitted (diaphaneity)—
  - —Transparent.
  - —Semi-transparent.
  - —Translucent.
  - —Opaque.

(2) Related to Heat—

- —Conductivity.
- —Dilatation.
- —Fusibility—
  - —1. Stibnite.
  - —2. Natrolite.
  - —3. Garnet.
  - —4. Actinolite.
  - —5. Orthoclase.
  - —6. Bronzite.
  - —7. Quartz.

(3) Related to Electricity—Some minerals are affected by a magnet; usually in the proportion of their iron. Apply the magnet to the pulverized mineral.

(4) Related to Cohesion—(*a*) Hardness—
- 1. Talc.
- 2. Gypsum.
- 2½. Mica.
- 3. Calcite.
- 4. Fluorspar.
- 5. Apatite.
- 6. Feldspar or orthoclase.
- 7. Quartz.
- 8. Topaz.
- 9. Sapphire.
- 10. Diamond.

NOTE.—1 to 2½ can be scratched by the finger-nail; up to 3 by copper; up to 5 by glass; up to 7 by a knife-blade.

(*b*) Tenacity—
- Brittle.
- Sectile.
- Malleable.
- Flexible.
- Elastic.

(5) Related to Cleavage if crystalline—
- Basal.
- Cubical.
- Lateral.
- Octohedral.
- Rhombohedral.
- Diagonal.
- Prismatic.

(6) Related to Fracture—
- Conchoidal.
- Even.
- Rough.

(*f*) Their specific gravity.

(*g*) Their solubility. Frequently it is important to note the action of the pulverized mineral in hot hydrochloric acid.

(*h*) The manner of extracting a particular mineral from the earth.

(*i*) *Taste.*—Some minerals like common salt are soluble in water. These usually have a distinct taste—saline astringent, bitter, pungent or acid.

(*j*) *Odor.*—Many minerals on heating give off characteristic odors—sulphurous or that of garlic or of rotten horse-radish or of rotten eggs or of prussic acid.

Minerals fall into two great subdivisions:—(*a*) Metals, (*b*) non-metals.

All true metals have metallic lustre and are opaque in the thinnest sections.

The chief metals in Canada are gold, silver, platinum, lead, copper, nickel, and iron.

The chief non-metals are coal, asbestus, mica, clay, building-stone and apatite.

CHAPTER VI.

THE HEAVENLY BODIES.

The heavens declare the glory of God; and the firmament sheweth his handiwork. (Psalms xix, 1.)

Nothing is more fitted to direct the mind towards the infinite, and to make man bow in reverent humility, than the thoughtful contemplation of the starry heavens. To solve even one of the many mysteries that face him, as he thus contemplates, is to make him realize his possibilities and his dignity as the crowning work of God.

"Thou madest him to have dominion over the works of Thy hands." (Psalms viii, 6.)

From earliest times, man has been impressed with the splendor of the heavens. They have had an indefinable attraction for him, as, from the depths of their silence, they have spoken to him concerning truths he has been able to understand only partially.

The systematic study of the phenomena of the heavens, however, dates back only a few thousand years. The Chaldean shepherds are looked upon by many as the first astronomers. But it is only within recent years that people in general have been rising to an intelligent appreciation of their privileges in this direction, or that the ordinary mind has been considered capable of grasping any more than the most superficial facts relating to the heavenly bodies.

Children seem instinctively interested in the starry firmament. If teachers and parents wish to be convinced of this, they have only to watch the little faces, as in wonder, love and admiration, they frequently gaze up into the sky. Listen to their questions! How shall we answer them? To meet the questions, relating to the heavens, which children ask, does not require greater effort on the part of the teacher than it does to meet their questionings in any other subject, provided teachers are as well prepared. Every teacher should have, at least, a general knowledge of the heavenly bodies.

The Starry Heavens.

Clusters and beds of worlds, and bee-like swarms
Of suns and starry streams.

—*Tennyson.*

"What are the heavens? Where the shores of that limitless ocean; where the bottom of that unfathomable abyss? What are those brilliant points—those innumerable stars, which, never dim, shine out unceasingly from the dark profound?"—*Guillemin.*

Even the greatest astronomical genius, with the most powerful of telescopes, cannot answer Guillemin's first question. In attempting to do so, the finite mind is lost in those unspeakable depths and cries, "What is man and his inventions! Answer Thou 'who coverest thyself with light as with a garment: who stretchest out the heavens like a curtain.'" (Psalms civ, 2.)

With reference to Guillemin's second question, it may be said that, though most of these brilliant points are so far distant that the most powerful instruments can distinguish them only as the faintest specks, yet some of them are accessible to the investigation of man, and his diligent research has been rewarded with a partial answer to the question.

The stars that light the heavens to their limitless shores are suns with characteristics similar to ours. This vast multitude of suns forms the sidereal universe. The ancients imagined the stars to be grouped into fanciful figures resembling at times a human being, an inferior animal or other object. These groups of stars are known as the constellations.

The Milky Way, that whitish glimmer that encircles the heavens, is by some regarded as nothing more than a zone of stars crowded closely together, most of them being so distant that they are not separately visible to the naked eye.

The stars are not scattered broadcast without order in the heavens; each is related to the other and regulated in its movements by immutable laws. Order and harmony everywhere prevail.

> "*Thou* hast made thy creation all anthems,
> Though it singeth them silently."

So far distant are these stars that their movements were formerly not discerned; hence they were called *fixed* stars.

THE SOLAR SYSTEM.

Thou, Lord, in the beginning hast laid the foundation of the earth ; and the heavens are the work of thy hands. (Heb. i, 10.)

The group of heavenly bodies to which our earth belongs has for its centre the sun. Around this centre and at various distances from it, revolve the planets. These bodies are not like the sun, self-luminous. They have no light of their own and would be invisible to us, if the light they received from the sun was not reflected towards the earth. This reflected light makes them appear to us as stars. As these bodies are near enough to the earth to allow their movements through space to be noted in a comparatively short interval of time, they have received the name *planets*, or *wanderers*. The planets arrange themselves naturally into three groups. First :—*The smaller planets*. These are in order of their increasing distance from the sun: *Mercury*, *Venus*, *the Earth*, *Mars*. Second :—*The larger planets* and those most remote from the sun: *Jupiter*, *Saturn*, *Uranus*, *Neptune*. Third:—*The minor planets* or *Asteroids*. The Asteroids occupy the space between the orbits of Mars and Jupiter and thus separate the two former groups from each other. About five hundred of these are now known.

Some of the planets are accompanied by satellites, or moons, such as the one that accompanies our earth. Mars has two such moons ; Jupiter, five ; Saturn, nine ; Uranus, four ; Neptune, one.

Besides the planets and their satellites, a number of *comets* have been observed to return periodically and revolve round the sun. These are called periodic comets. There are about thirty of them now known. The group of celestial bodies, of which our earth forms a part, is perhaps the most important member ; it is called the Solar, or Planetary System.

The direction of the movement of revolution is the same for all the members of the Solar System. Their orbits are elliptical. The planes of their orbits do not

coincide with one another. If the plane of the orbit of the earth is taken as a standard of reference, that of each of the other planets is differently inclined to it. These inclinations, as seen from our earth, are very small and the zone in which the planets revolve very narrow. This zone is called the *Zodiac.*

The time taken by each of the planets, in journeying round the sun, differs greatly. Our earth makes the journey in three hundred and sixty-five days, or one year, Jupiter in twelve of our years, Saturn in twenty-nine, Uranus in eighty-four and Neptune in one hundred and sixty-five.

To show the comparative sizes of the planets, and their relative distances from the sun, Agnes Giberne has made the following calculations.

Let us suppose the sun to be nine feet in diameter. The planets would then be represented thus:—

Mercury,	by a	ball	½	inch in diameter	placed	100	yards	from	the sun.
Venus,	"	"	1	"	"	"	200	"	"	"
The Earth,	"	"	1	"	"	"	¼	mile	"	"
Mars,	"	"	1⅛	"	"	"	⅜	"	"	"
Jupiter,	"	"	10	"	"	"	1	"	"	"
Saturn,	"	"	8½	"	"	"	2	miles	"	"
Uranus,	"	"	4	"	"	"	4	"	"	"
Neptune,	"	"	4¼	"	"	"	6	"	"	"

Idea of distance is best shown by the time it takes to travel a certain distance. Our earth is comparatively near the sun. But, if one were to travel in an express train at the rate of thirty miles an hour, it would take three hundred and sixty years to complete the journey from the earth to the sun.

The Moon.

"Soon as the evening shades prevail
The moon takes up the wondrous tale,
And, nightly to the listening earth,
Repeats the story of her birth."

Who does not love the moon? To those who are at all sensitive to the beauties of nature, the moon with her soft, calm light is restful and inspiring.

The moon is the nearest heavenly body to the earth. It is approximately 240,000 miles distant. An express train travelling at the rate of thirty miles an hour would reach the moon in about eleven months.

During intervals of about twenty-nine and a half days, the moon is seen under a series of appearances which are called phases. These phases occur in regular order and within definite periods of time.

The moon turns on its axis in the same length of time as it takes it to journey round the earth. Hence it always presents the same side to the earth. Its path is elliptical.

The moon, like the planets, is illuminated by the sun. The light is reflected from the moon to the earth and makes it visible to us.

It is only when the sun and moon are on opposite sides of the earth that the whole of the illuminated hemisphere is visible. When the moon is between the sun and the earth the dark hemisphere of the moon is turned towards the earth and, so, no moon is visible.

There is a *new moon* at the time when the moon and the sun are on the same meridian in the sky. About four days elapse between the disappearance of the moon in the east in the morning, and its reappearance in the west a little after sunset.

When first seen as new moon, we observe it in the form of a very slender *crescent*. The convex side of this crescent is turned towards the point below the horizon occupied by the sun. As the moon proceeds on its monthly journey, more and more of its bright face is seen until it reaches full moon. At its first quarter, half of the illuminated hemisphere is visible and the moon sets about six hours later than the sun.

Between the first quarter and *full moon*, seven days elapse. At full moon, it is on the opposite side of the earth to the sun, on a plane usually a little lower or a little higher than that of the orbit of the earth. As the

illumined part is approaching a complete circle, the circular portion of the disk is always turned towards the western part of the heavens. From the time of full moon till the next new moon, the circular form of the visible disk diminishes by degrees, until the moon appears again as a slender crescent. This time, however, the convex side, being still turned towards the sun, is directed towards the eastern part of the heavens. As the moon journeys onward in this, its *last quarter*, the crescent disappears altogether, and the moon is lost once again to our view.

During the first and last quarters, the dark portion of the moon's disk is dimly visible. This part is seen by light which is reflected from the earth to the moon and then reflected from it back to the earth.

THE STARS

How distant some of these nocturnal suns !
So distant (says the sage) 'twere not absurd
To doubt, if Beams, set out at Nature's Birth,
Are yet arrived at this so foreign World ;
Tho' nothing half so rapid as their Flight.

—*Young.*

In the middle of a large sheet of pasteboard, place a small sphere, half of it above and half below the sheet, to represent the sun. At a little distance from the sun, place the earth with its axis slanting, half above and half below the board. If the other planets travelled on the same plane as the earth, they too could be placed in the board, but as the plane of the paths of none of them coincides with that of the earth, they must not have a place in the board. The pasteboard divides the space above from the space below. In a similar manner, the path or orbit of a planet divides space in the heavens. The heavens, as we have noted before, are lit everywhere by millions of stars.

The people in the northern latitudes of our earth see an almost entirely different set of stars from that which people, living in southern latitudes, see.

The stars, *visible* to the naked eye, have been mapped and numbered. There are from three thousand to four thousand in the northern heavens and from four thousand to six thousand all round the world thus visible. Sir William Herschel calculated roughly that twenty millions could be seen with his telescope, and the number within reach of our present telescopes may exceed one hundred and twenty-five millions.

Some stars are brighter than others. The degree of brightness of a star is termed its *magnitude.* Stars can be seen with the naked eye to the sixth magnitude.

All stars are not of the same color. Some of them are white, like the sun; others are golden or orange; others, again, are red or ruby, and some are blue.

There are stars, which to the unaided eye look like single ones, but become separated into two or more when viewed through a telescope. These are called double, triple, quadruple, or multiple stars, according to their number.

A group or cluster of fixed stars is generally called a *constellation.* In most cases, constellations are designated by the name of some animal or mythological personage within whose outline, as traced upon the heavens, the group is included.

In order to obtain a knowledge of the constellations, it is necessary to follow the apparent revolution of the heavens for a year. In consequence of the journey of the earth round the sun, the whole heavens appear to make one revolution in that time.

Beside the annual revolution of the heavens, there is a diurnal revolution caused by the daily rotation of the earth on its axis. The complete circuit made in each case is three hundred and sixty degrees; hence in two hours of daily revolution, the stars will change their places to the same extent as in one month of the annual revolution. If we could watch the heavens for

twenty-four hours without being interrupted by daylight, we would behold the complete circuit of the stars just as we would, if for a year, we could look at the heavens at a particular hour every night.

An important constellation in the northern sky is that of which the Pole star is the chief member. This constellation is called the Little Bear (*Ursa Minor*). There are also two other conspicuous stars in this group, called the "guards." The Pole star is the most important one in the northern heavens, because it marks very nearly the position of the North Pole in the sky. This star remains almost in the same place in the sky, while the other stars change their places from hour to hour.

Around the north celestial pole as a centre, the different constellations seem to revolve. The movements of the ring of constellations within forty degrees of the Pole star can be easily marked. They are visible the whole year round.

By facing directly north and looking up forty-three degrees at Toronto, forty-five at Halifax, fifty at Winnipeg, or about half way between the horizon and the zenith, the North star will be noted. This star may be more readily found by noting its position as related to the constellation, the Great Bear—seven bright stars of which are called the "dipper." The two stars in the outer edge of the bowl point almost directly to the North star. These two stars are called the "pointers."

Alpha Centauri is supposed to be the nearest fixed star to our earth. It takes four and a third years for the light from this star to reach the earth.

Sirius is the brightest fixed star. Light reaches the earth from this star in eight and a half years; from the Pole star, in forty-seven years and, from Capella, in thirty-two years.

The distance of the fixed stars from the earth is so enormous that a new unit of measurement is required. Astronomers use the *light year*, *i.e.*, the distance travelled

by a light wave in one year, as the unit with which to measure the distance of the fixed stars. Some slight conception of the enormous distance of these stars may be obtained from knowing that the velocity of light is about 186,000 miles per second and in a year that it travels about 5,880,000,000,000 miles.

By observation of the heavens, the position of all the important constellations, visible from the place of the spectator, may be discovered and their names readily found in a chart of the stars.

CHAPTER VII.

SUGGESTIONS FOR THE MONTHS.

O what a glory doth the world put on
For him who, with a fervent heart, goes forth
Under the bright and glorious sky, and looks
On duties well performed, and days well spent!

—*Longfellow.*

Weather.—By weather is meant the state of the air, or atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness, or other meteorological phenomena.

For the sake of convenience, however, the subject-matter classed under this head will not only include the weather proper, but will encroach upon the provinces of astronomy, physics and chemistry, which are required to explain many phenomena connected with the weather.

Suggestions for Observing the Weather.

1. Make daily observations.

2. Record observations each day at a special time set apart for such work.

The period directly after dinner is a good time for recording observations. Before the pupils go home for dinner, the teacher should remind them to take obser-

vations. If they are formed into lines before entering school, a few minutes' open-air observations and talk at that time will be found profitable.

3. Encourage individuality. Truth is many sided and power to discern even one of the many sides does not come at once. One phase of truth may be seen by one child; another phase, by another child.

4. Endeavor to make the pupil accurate in his statements concerning his observations.

5. Whenever possible, teach the child GEMS OF LITERATURE or SHORT POEMS, bearing particularly on the different months or on any special phenomena.

Read "Is it Going to Rain?" in *Locusts and Wild Honey*, by John Burroughs.

Emphasize the particular beauty of each season.

AUTUMN.

Season of mists and mellow fruitfulness,
Close bosom-friend of the maturing sun,
Conspiring with him how to load and bless
With fruit the vines that round the thatch-eaves run.

—*Keats.*

SEPTEMBER.

Weather.—Make observations on winds, clouds, rain and temperature. In what respects does the weather of this month differ from that of July and August?

Mammals.—Observe the cat, the cow and other quadrupeds as to their preparation for the different seasons. Has the cow made any preparation for winter by way of storing foods? Has any preparation been made for her? If so, in what way? Has the cat stored any food?

What preparations do wild quadrupeds make for winter? Note the following: Rebuilding and repairing of summer homes, or building winter homes; storing food; becoming fat in the autumn; growing an extra coat of fur or hair. Why do not domestic animals make the same preparations for winter as wild ones?

Birds.—Observe the migration of birds. Note those which leave this month. Which birds remain with us?

Plants.—General observations are to be made by the pupils. Take up the life-histories of such plants as the apple-tree, the maple, carrot, wheat and golden-rod. What have the plants been doing all summer? How are the seeds in the apple protected? Compare the manner of protecting apple-seeds with that of other seeds and the apple with different kinds of fruit. Do all plants produce seeds each year? Compare annuals with biennials.

Leaves.—Are there any new leaves coming on the trees? Are there any new buds? Are any leaves falling off the trees?

Seeds.—Observe what seeds are sown during the month. Why are these sown at this time?

OCTOBER.

Weather.—Every day, have observations on the following points: (*a*) Direction of the wind. (*b*) Velocity of the wind—calm, light, moderate, high. (*c*) Kinds and names of clouds, and the weather indicated by each. Compare the direction and temperature of wind in October with that in September.

Rain.—Observe the general appearance of the sky. Why the dark appearance? What kind of clouds usually bring rain? How does the wind affect clouds? Observe the effect of rain upon the ground.

Mammals.—Observe what mammals store winter food. Note the kind of food stored. Compare the present covering of the cow, horse and sheep with that last month.

Birds.—Note the birds that migrate during this month. Discover whether birds of different kinds travel together. What forms the food of those that remain?

Insects.—What insects are still to be seen?

Plants.—Note the following: Fruit yet maturing; fruit seemingly wasted; roots used for animal food; how fruits

and roots are gathered; how they are stored. Draw attention to the number of seeds that fall to the ground. Do these seeds die? How are they protected? Observe how the wind helps them. Note winged seeds, fluffy seeds. How do animals help plants in scattering their seeds? Which seeds germinate this month? Note fall wheat particularly. Be on the lookout for any fresh growth, and the circumstances under which it begins.

Leaves.—Why are the leaves falling? Are the fallen leaves of any use? Why would it be of no benefit to the plant for leaves to remain on it?

Flowers.—What flowers are still in bloom? Are these annuals, biennials or perennials?

Note how some plants protect themselves by storing food either in fleshy roots, or in their stems. Have plants any enemies, in their struggle for life? Note the following: Loss of seed when the flower is plucked; that many of our most beautiful wild flowers are becoming rare; that too many are carelessly plucked. This is a good time of the year to note such enemies of certain fruits as the codling-moth, the gall-fly, the nut-weevil.

November.

Weather.—Review winds, cloud, rain. Teach any new phase that may present itself this month.

Comparison with September and October.—What is the most common form of cloud this month? Is the direction of the prevailing wind the same as it was during September and October? Why are the days colder? Why are the days shorter? How does rain affect the temperature?

Mammals.—What provision do some quadrupeds make against hunger? Observe the uses of mammals (*a*) to the farmer, and (*b*) to the merchant. Draw attention to the

killing and shipping of animals at this time of year. Note the necessity of oily food for cold weather. Consider the value of fur-bearing animals; where these are found; the use of their heavy fur-coats; how fur protects the wearer from the cold.

Birds.—Observe what birds are still to be seen. Note the places they now frequent. Compare their actions now with those in September.

Insects.—What insects or caterpillars can be found at this time of the year?

Plants.—Examine the twigs of different trees. Compare them with those of the beech and maple. Note the buds; the color of the leaves; why the new buds form with this season; where they form; which kind of tree sheds its leaves first. Speak of the effect of sunlight on the coloring matter in the leaf-cell. Press, paint and sketch leaves. Why do herbaceous plants not form new buds on their stems? Note the difference between the stems of plants that form new buds and of those that do not.

Seeds.—Gather as many seeds as possible.

Note the dependence of certain animals on nuts; also how they repay the tree for its food by finding new homes for many of its seeds.

Flowers.—Examine as many fall flowers as can be gathered. Note their color and arrangement. Compare them with flowers studied in the spring.

WINTER.

See, Winter comes, to rule the varied year,
Sullen and sad, with all his rising train:
Vapors, and Clouds, and Storms. Be these my theme:
These, that exalt the soul to solemn thought.

—*Thomson.*

DECEMBER.

Weather.—Review wind, clouds, rain, frost, temperature and light. Note any new phase apparent this month.

Comparison with September, October and November.—Continue comparisons similar to those under November. Observe the height of the sun at noon. On what day is the shadow cast by an object at noon longest?

Snow.—Observe the sky during a snow-storm. Note particularly the wind and the temperature; compare the temperature during the storm with that before it began to snow.

Review points bearing on the evaporation of water and the formation of clouds. Examine and sketch snowflakes; note their beauty. Melt snow. Pack snow. Allow melted snow to freeze; note what causes the change. After the snow is melted into water how can it be formed into flakes again?

Uses of Snow.—Observe the uses of snow to plants and to animals. Tell stories of the snow-houses of animals and men. Note the amount of water from melted snow. What effect will the water have upon the earth? Consider the effect of the weight of snow upon trees, if the leaves are on them. How does snow affect evergreen-trees?

Lesson on Crystals.—Select such substances as soda, salt, alum, that will dissolve in water. Dissolve, say, alum in water. What is the cause of the disappearance? Heat the water and form a saturated solution. Suspend a string in the solution; let the solution cool slowly. What happens? Examine the forms on the string. Perform similar experiments with soda and salt. Compare the shapes of the various crystals which are found.

There is no chance work in nature. Law underlies every step she takes.

Mammals.—The fox, rabbit and hare are almost the only common wild mammals to be seen. Why should man protect such animals as the sheep, cow, horse, etc.? How does he benefit by protecting them? We are always responsible, whether we gain or not, for that which is placed under our care.

Observe the following: The coverings of different quadrupeds; their movements, their weapons for protection, the general structure of their bodies, and the different kinds of food they use.

Birds.—Do birds ever sing at this time of the year? When do they sing their best songs? Try, if possible, to get where the winter chattering of birds can be heard. Compare their dread of man now with that in summer. Be on the lookout for the screech-owl, the chickadee.

Insects, Worms, Fish.—Study, as circumstances allow, collections made in autumn.

Plants.—Begin the study of evergreens. Observe the pine and cedar. Continue the study of nuts.

Note the effect of December weather on trees in general. What is the advantage to a tree of being leafless? Compare the pine leaf with that of the beech or maple. What is the effect of snow on each kind of leaf? Observe how buds are protected from frost. Notice the general beauty of form of trees when stripped of their leaves. How has the tree protected itself against cold weather?

Observe how plants serve animals in winter. Note the following: Birds looking for clinging seeds, also for insects buried in the bark; insects making their homes in trees; squirrels finding their homes in trees; evergreens protecting hosts of birds and their seeds forming the chief food for many of them.

Roots.—What roots useful to man are left in the ground during the winter?

JANUARY.

The years, like clouds, they come and go;
 Some dark and tearful, drench the heart;
 Some bright and warm, are hope's glad dart.
And all are sent from friend, not foe.

The years are teachers, wise and true,
    Imparting knowledge, rich and rare,
    To brighten life, drive out despair,
And all Divine in us renew.

The years are pilots, skilled and keen,
    From shoals and tides to set us free,
    To guide us to the open sea,
And leave us there with the Unseen.

The years are pilots, kind and blest,
    The voyager to welcome home,
    Beyond the ocean's blasts and foam,
Secure in Heaven's untroubled rest.

Then let us greet the coming year,
    Whate'er its months and days may bring.
    Dear friend, God bless thee with His ring
Of joy and hope, in smile or tear.

—*G. M. Milligan.*

Weather.—Continue observations on winds, clouds, temperature, snow and ice, and make comparisons in respect to these with other months.

Ice.—During what kind of weather is ice formed on a pond? Give a lesson on solids and liquids. How can ice be made into a liquid form? Note the crystals in the ice. Observe ice when it is thin. What change in volume takes place when the crystals are forming? Note the power of ice in nature. Why is ice used as an artificial means of preserving meat and fruit? Of what use is ice in the sick-room?

Thawing.—Note the following:—The cause; the direction of wind; the general appearance of the sky; the temperature during the thaw; the effect of thaw on man and beast.

Plants.—Continue the study of evergreens. Compare the shape of these trees with that of deciduous trees. Note how their shape is adapted for winter weather; why the leaf has not fallen off; their special protection against cold; the special protection of their seed; the effect of wind, snow and frost on them.

Grass.—Examine the roots to determine whether it is dead or not. Note the provision for rapid growth in spring and how the roots left in the ground are protected. Compare these with the roots of the carrot. Note the effects on fall wheat, if the snow lies too deep on it or if it is too thin to protect it.

FEBRUARY.

Weather.—Continue observations on winds, clouds, temperature, rain, frost, snow, ice, light, color and heat.

Comparison with other Months.—Why are the days longer than they were in January? How does the length of the days compare with those of the same date in October? (Refer to records kept.) Is the temperature colder or warmer than it was at the same time of the day last month? What is the cause of the difference?

Note particularly the way in which the rays of light strike the earth at noon.

Time.—Practical ideas of time may be given to the child by allowing him a certain time for a given work. Teach the time on the clock. Have the pupils draw the face of the clock. Teach the way in which time is reckoned. Emphasize the importance of improving time. Call attention to different ideas of length of time. Read Hans Andersen's story on the Oak and the Ephemeral Fly.

Mammals.—Note the proper kinds of food for cold weather; the proper kinds of clothing; the effect of cold upon the horse; how it should be treated especially during cold weather.

Birds.—Where do the birds that remain with us get their food in the winter? What birds have you noticed picking seeds in the winter? Be on the outlook for quail, hairy woodpecker, meadow-lark and robin.

Plants.—Continue the study of evergreens. Add a new life-history, say the balsam spruce, or continue

the study of those already introduced. The study o seeds may be begun in the school-room by way of pre paration for watching spring growth.

Study seeds by planting them in boxes in the school room.

SPRING.

I come, I come! ye have called me long—
I come o'er the mountains with light and song!
Ye may trace my steps o'er the wakening earth,
By the primrose-stars in the shadowy grass,
By the green leaves opening as I pass.

—*Mrs. Hemans.*

MARCH.

This is the first spring month. Nature is still in her winter garments, although some of the sounds of spring are heard.

It is a most opportune month to begin the study of out-door life. The world of nature, it has been said, is the month of March. This is a month of expectancy and surprise. While one is bidding good-bye to winter, spring often bursts out without warning, and with a miraculous suddenness that quickens every sense. This statement is more true, generally speaking, of our April than it is of March, though these two months frequently cross hands and the weather of the early April days in one year is frequently the weather of the last days in the March of the preceding year. Be on the lookout for returning life.

Winds.—What marked change is there in the winds? From what direction do they come? Compare the direction of the prevailing winds with those of February. Note also winds on cloudy days, on wet days.

Clouds.—Note the clouds at different times during the day. Note clouds during high wind; when the temperature is warm; when the temperature is low.

Rain and Frost.– Compare these with the rain and frost of previous months.

Light.—Watch sunrise and sunset.

Mammals.—Note the effect of spring weather on quadrupeds already observed. Which of the hibernating ones have awakened? How do mammals change their coats?

Birds.—As soon as possible observe the following:—The crow; the song-sparrow and phoebe singing and calling to their friends; the robins hunting for food and homes; the tree-sparrows filling the thickets; the bluebirds and purple finches singing here and there. How can you tell the birds that migrated last fall? Did they return singly or in flocks?

Insects.—Are there any signs of life in cocoons? Have any insects come out of their winter homes? Watch, if possible, bees at the sap of the maple.

Plants.—Notice the effect of March weather on plant life already under observation. Begin new life-histories, as those of the elm and the willow. How do twigs or buds show signs of fresh life? During the last days of this month, the willows may frequently be seen to grow green and yellow and the poplars tawny and shining. The sap shows fresh signs of life. The light has changed and even the bare twigs seem to know it and rejoice in the fact. Note the effect of light upon plants kept in a cellar.

Forcing Blossoms.—The study of the blossom may be begun this month. Put a few twigs in water in a warm place. In a short time they will burst out into full leaf or into blossom. During the study of plants the following should be noted: Oxygen given out by plants is breathed by animals; the carbon dioxide exhaled by animals is used by plants. Hence to keep plants in the house and the school-room during sunlight is conducive to health.

APRIL.

Weather.—Make observations on rain, light and heat.

Comparison of April with other Months.—Note the difference in the following:—Temperature, winds, rain,

general appearance of sky, the time of the rising and the setting of the sun, the height of the sun at noon.

Time.—Observe that the length of day is increasing; note the advantages of this to animal and vegetable life.

Fog.—Observe fog to discover what it is and its cause.

Mammals.—Observe the cattle in the fields. What change have you noted in their coats? Upon what food do they live? How do they treat their young? Note particularly lambs, calves, colts, little pigs. Observe wild quadrupeds as to their food, their covering and their habits.

Birds.—How does the hen spend her time on bright days? Notice her habits of scratching, bathing, laying eggs. What birds have begun to build their nests? Do any of them occupy last year's nests? How do the new comers, as the red-winged blackbird, the meadow-lark, the robin, and the blackbird, behave themselves on their return? In what do they seem to take most delight?

Insects.—What were insects doing when you saw them flying about? Are they of the same kind as those you have observed before, or are they of a different kind? (Refer to autumn observations.)

Worms.—How do you know that earthworms are busy? Compare their spring and fall work. How does the work of the earthworm benefit plant life?

Fish and Frogs.—When do fish begin their work? Where have the frogs been all winter? What work have they to do?

Plants.—Notice that life is everywhere. Note the general appearance of trees.

Buds.—Examine buds to discover whether there is life in each one. What effect had the frost upon them? Which develops first, the leaf-bud, or the flower-bud? How do buds throw off their protecting scales? Is there any change in the general appearance of ever-

greens? Where are the buds on evergreens situated? Observe the flowers of evergreens; note their situation and appearance.

Leaf.—Which tree sends out its leaves first? Note the following points:—The way in which the leaves are folded in the buds; how the leaves spread out to the sunlight; why some plants put forth leaf and stem sooner than others.

Stem.—Observe how the stem is fitted, in every way, to support the branches and leaves; note the coverings of different kinds of stems.

May and June.

Weather.—Continue observations on wind, clouds, temperature, etc.

Soil.—Note agencies at work preparing it for the life and growth of plants. In what way do the following affect soil: Snow, ice, frost, rain?

Rain.—Compare summer rains and winter rains. Be on the lookout for a rainbow. Observe the conditions present at the time of the rainbow?

Hail.—Observe the conditions under which it occurs. Infer the cause of hail. Note its effect on plant life.

Dew.—What is the cause of dew? Note its effect on plant life.

Study the Landscape.—Note its general appearance; (1) when near; (2) when far away; (3) in the morning light; (4) in the evening light. Select spots particularly beautiful. Why do we say they are beautiful? What agencies are at work changing landscapes? Note running and standing water. If possible, trace a brook from its source to its mouth. Observe how it is enlarged and the work it accomplishes.

Family Life.—Particular attention should be given, during May, to young animals. Observe the kindness of the male and female to each other and to their

young; note the dependence of the young on their parents; observe the provision which nature has taught the mother to make for them.

Mammals.—Observe the kindness of the cat to her kittens; of the cow to her calf; of the sheep to her lamb.

Emphasize the particular use of the following animals to man: The cow—milk, butter, cheese, meat; the horse—necessary for work; the sheep—the wool taken off at the end of this month or the beginning of next.

Birds.—Observe the following:—Selection of their homes; the building of nests; the different kinds of materials used; how they are protected against enemies; different sizes and coloring of eggs; how a bird is fed when sitting on the eggs.

Emphasize the use of the following birds:—

BIRDS.	WHAT THEY DESTROY.
Marsh-hawk.	Meadow-mice.
Screech-owl.	Grasshoppers, may-beetles, wood-borers.
Crow.	Cut-worms.
Meadow-lark.	Cut-worms, wire-worms.
Baltimore-oriole.	Leaf-eating caterpillars and beetles.

Insects.—Notice how the eggs are protected. Compare the eggs of an insect with those of a bird. Review different stages of insect life. Observe how the young are fed.

Note the following insects useful to man:—The bee, the house-fly, the dragon-fly, the beetle and the ant.

Cocoons.—Notice how cocoons are protected from moisture.

Plants—Everywhere we see growth and change. Note the change in the plants under special observation. Add new life-histories, as those of the oak and the hepatica. Mark the effect of May rains, sunshine

and wind, on plant life in general. Note planting corn and roots, and cutting clover.

Special Study of the Leaf.—Note the number of leaves on a small apple, oak or maple tree. Place the leaves side by side and show the large surface exposed to the air.

Blossoms of Trees.—Observe the individuality of different blossoms. Note their color, durability, etc.

Interest the child in watching the fruit develop, also in watching the enemies that attack it.

Wild Flowers.—Where are wild flowers found? Where do they grow in greatest profusion? Transplant some and observe how each flourishes in its new home. Observe the habits of different kinds. Notice what insects frequent them.

Emphasize.—Everything in nature has a destiny to fill, a life to work out. Unless there is growth and change there must be stagnation—death.

July and August.

After looking back upon the work for the year, note the weak points and direct the pupils what observations to make during July and August.

Pupils may be asked to keep a note-book, jotting down anything that is new or strange to them. During the first week of school, after the summer vacation, attention may be given to observations made during the holidays. Some of the children may have the advantage of spending their holidays in a part of the country entirely different from that about their homes; hence, such observations can be made very interesting and very instructive to the class as a whole.

Plants.—July is the month of the song of the reaper—the month of hay-making and wheat-harvesting. August is the month when wheat, barley, pease, etc., are gathered in. *Encourage the children to watch these different operations during the holidays.*

CHAPTER VIII.

BOOKS AND AIDS.

Nature-Study (general).—Many so-called Nature-study books have been published in recent years, but the authors of several of them have misconceived the purpose and the method of the subject. When the book comes between the child and the object of investigation and by statement or picture supplies the knowledge that the child should discover by his own investigation, then it defeats its purpose. Such books, although injurious in the hands of the pupils, may, notwithstanding, be useful to the judicious teacher.

Nature-Study and the Child. By C. B. Scott. Pages 618; price $1.50. D. C. Heath & Co., Boston. This book discusses the pedagogics of Nature-study, gives a typical treatment of the dandelion and the rabbit and the outlines of many other lessons.

Nature-Study for Common Schools. By W. S. Jackman. Pages 448; 2nd ed. 1894; price $1.30. Henry Holt & Co. The opening chapters treat of motives and principles; the body of the work suggests exercises in zoology, botany, physics, chemistry, meteorology, astronomy, geography, geology and mineralogy, arranged on the basis of suitability for each of the school months. This author has written several other works on the subject, one of which, "Field Work in Nature-Study," has an admirable chapter on "The River Valley."

Systematic Science Teaching. By E. G. Howe. Pages 321; price $1.50. International Education Series. This book consists of twenty-three series of graded lessons or suggestions for teaching them. "Step V," for example, is called "Acquaintance With a Few Home Animals," and offers suggestions as to the object, time, material and preparation by the teacher, followed by outline lessons on boy, cow, hen, snake, frog, goldfish, moth and snail.

Object Lessons. By David Salmon. Pages 238; price $1.25. Longmans. This is one of the best English books on the subject.

BIOLOGY.

Boyer's Elementary Biology. Pages 234; price 80c. net. **Studies of Animal Life.** By Walter, Whitney and Lucas. Pages 106; price 50c. net. And **Studies of Plant Life.** By Pepoon, Mitchell and Maxwell. Pages 96; price 50c. net, published by D. C. Heath & Co.; these are useful laboratory books.

Zoology.

Elementary Lessons in Zoology. By J. G. Needham. Pages 310; price 90cts. The American Book Co. A guide to the study of animal life in the field and laboratory.

Animal Life. By Jordan and Kellogg. Pages 329; price $1.20 net. Appleton & Co. An illustrated animal ecology. "Adaptations," "Animal Communities," "Homes and Domestic Habits," are titles of three of its sixteen chapters.

Manual of the Vertebrates. By D. S. Jordan. Pages 397; price $2.50. A. C. McClurg & Co. This is the best available book for the identification, by artificial analytical keys, of our mammals, birds, reptiles and fishes.

Ornithology.

Handbook of the Birds of Eastern North America. By F. M. Chapman. Pages 427; price $3.00. Appleton & Co. This book contains systematic keys for identification, and good descriptions. Coue's Key to North American Birds ($7.50) is a standard work.

Birds of Village and Field. By F. A. Merriam. Pages 406; price $2.00. This is entitled "A Bird-Book for Beginners," but it is deservedly popular with advanced students as well. It gives a color-key for the identification of birds in the field.

Birds of Ontario. By Thomas McIlwraith. 2nd ed. Pages 426; price $2.00. Wm. Briggs. This gives an account of all the Ontario birds, with descriptions of eggs and nests, but lacks a key for identification.

Davie's Methods in the Art of Taxidermy is a manual of the art its title indicates.

Entomology.

Manual for the Study of Insects. By J. H. Comstock. Pages 701; price $3.75. Comstock Pub. Co. This is the best manual of insects for Canadian students. The same author's **Insect Life,** 350 pages, treats satisfactorily of the general anatomy, collection and preservation of insects and of the life-histories of a large number of common insects, arranged on the basis of their habitats.

The Insect Book. By L. O. Howard, and **The Butterfly Book,** by W. J. Holland, are two excellent illustrated works published by William Briggs, Toronto, at $3.00 each.

Entomology for Beginners. By A. S. Packard. Pages 367; price $1.40. Henry Holt & Co. A book that can be recommended.

All the Annual Reports of the Entomological Society of Ontario, published by the Department of Agriculture for the Province, contain illustrated papers on the Economic insects. Reports for the years 1896 and 1898 contain papers on Entomology in the Public Schools.

Botany.

Systematic manuals for the identification of plants are :

Spotton's Canadian Wild Plants. 3rd ed. 1897. Pages 308.

Gray's Manual of Botany. 6th ed. 1890. Pages 760.

Gray's Field, Forest and Garden Botany. Pages 519. The last-named book is now bound with Leavitt's Outlines of Botany for Laboratory and Class Room. Pages 272 + 519; price $1.80. American Book Co.

The following books can be recommended : Spalding's Guide to the Study of Common Plants, 294 pages ; Beal's Seed Dispersal, 87 pages ; Sargent's Corn Plants, 106 pages. Bailey's Botany, Bailey's Lessons with Plants, Barnes' Plant Life, Atkinson's Lessons in Botany, Coulter's Plant Relations—all of about 300 pages each are recent and excellent text-books.

Geology and Mineralogy.

Dana's Text-Book of Geology. By J. D. Dana. 5th ed. by W. N. Rice. Pages 480 ; price $1.40.

Elementary Geology. By R. S. Tarr. Pages 499 ; price $1.40. Beautifully illustrated, readable and reliable.

Tables for the Determination of Common Minerals. By W. O. Crosby. Pages 106 ; price $1.25. 3rd ed. The tests are mainly physical ; hence the suitability of the work for beginners as well as for field mineralogists.

Dana's Minerals and How to Study Them, $1.50, is a popular text-book.

Microscopy.

Practical Methods in Microscopy. By C. H. Clark. Pages 219 ; price $1.60. D. C. Heath & Co. A useful manual of microscopy.

Astronomy.

A New Astronomy. By David P. Todd. Pages 480 ; price $1.30. American Book Co. A good high school text-book, not overloaded with mathematics.

Astronomy with an Opera Glass. By Garret P. Serviss. Pages 158 ; price $1.50. Appleton & Co.

Astronomy by Observation. By Eliza A. Bowen. Pages 90 ; price $1.00.

Star-Land. By Sir Robert Ball. This author has written several other popular, interesting and thoroughly reliable works on astronomy.

Note.—The above prices are subject to change.

For the School Library.

Rab and his Friends, and Beautiful Joe are two fine biographies of dogs. **Black Beauty** is a matchless biography of a horse. **Blatchley's Gleanings from Nature** has a good chapter on snakes. **Bate's Naturalist on the Amazon** is a classic. Interesting, sympathetic and reliable accounts of animal life will be found in all or nearly all the books written by Ernest Seton Thompson, Dr. C. C. Abbott, John Burroughs, Bradford Torrey, Richard Jeffries, H. D. Thoreau, Arabella Buckley, Neltje Blanchan, Rev. Wm. J. Long, Jane Andrews, Mabel Osgood Wright.

Poems.

Unless the student of nature has through his studies been led from nature up to Nature's God and thereby enabled to realize the significance of root and rock, of life and function which are everywhere revealed in the "manuscript of God," the study of nature has been pursued to little purpose. The poet often helps the student to a higher appreciation of the book of nature. Hence the following list is given to suggest where the teacher may find references to any particular part of the work under consideration. From the very necessity of the case the list is only a partial one:—

Bird-Life.

Lord Tennyson.

The Dying Swan.
Song to the Owl.
The Blackbird.
The Throstle.

William Cullen Bryant.

To a Water Fowl.
Robert of Lincoln.

William Wordsworth.

To the Cuckoo.
The Green Linnet.
To a Skylark.
The Wild Duck's Nest.

Robert Burns.

The Woodlark.

Henry Wadsworth Longfellow.

Description of Mocking Bird (Evangeline).
The Bird and the Ship.
The Bird of Kellingworth (The Poet's Tale).

John Greenleaf Whittier.

How the Robin Came.
The Robin.

Mrs. Hemans.

The Messenger Bird.
The Bird's Release.

Percy Bysshe Shelley.

To a Skylark.

John Keats.

Ode to a Nightingale.

Flowers and Trees.

Mrs. Hemans.

The Dial of Flowers.
Bring Flowers.

John Greenleaf Whittier.

The May Flowers.
Jack in the Pulpit.
Lines Written for Horticultural Society, 1858.
The Trailing Arbutus.

Robert Montgomery.

The Daisy.

Robert Burns.

To a Mountain Daisy.

Jean Ingelow.

Seven Times One.

Lord Tennyson.

The Flower.
The Lotus-Eaters.

William Wordsworth.

The Daffodils.
To the Daisy (No. 1).
To the Daisy (No. 2).
A Flower Garden.
To a Snowdrop.

James Russell Lowell.

Violets! Sweet Violets!
There never was a Flower Fair in View—Sonnet xi.
With a Pressed Flower.
The Oak.
To the Dandelion.

The Seasons.

Henry Wadsworth Longfellow.

Autumn.
Spring.
Woods in Winter.
An April Day.

Mrs. Hemans.

The Voice of Spring.
Harvest Song.
Breathing of Spring.
The Parting of Summer.

Lord Tennyson.

The Progress of Spring.
In Memoriam cxv (Spring).
Winter.

John Keats.

Ode to Autumn.

William Wordsworth.

Summer Ebbs.
It Was April Morning.
The Longest Day.

William Cowper.

The Winter Evening.
The Winter Morning Walk.
The Winter Walk at Noon.
("The Task.")

Thomas Hood.

Ode to Autumn.
Departure of Summer.

Robert Burns.

Up in the Morning Early.
The Winter is Past.

Archibald Lampman.

Winter Uplands.
Winter Break.
In November.
A January Morning.

John Greenleaf Whittier.

Autumn Thoughts.
Easter's Flower Gift.
The Peace Autumn.
For an Autumn Festival.

The Heavens.

Henry Wadsworth Longfellow.

Hymn to the Night.
Daybreak.
Twilight.
The Evening Star.
The Occultation of Orion.
A Day of Sunshine.
A Rainy Day.

Mrs. Hemans.

The Sunbeam.

Kirke White.

To the Moon.
On a Survey of the Heavens.

Thomas Hood.

Ode to the Harvest Moon.
Ode to the Moon.

Thomas Campbell.

The Rainbow.
The Evening Star.

William Wordsworth.

It is a Beauteous Evening.
Fair Star of Evening Splendor of the West.

Ralph Waldo Emerson.

The Snow-Storm.

Percy Bysshe Shelley.

The Cloud.
Ode to the West Wind.
To the Night.

Archibald Lampman.

Evening.
Heat.

James Russell Lowell.

Midnight.
The First Snow-Fall.
Summer Storm.
The Frost at Midnight.

William Collins.

Ode to Evening.